7.0 CUMULATIVE EFFECTS

Cumulative effects, as defined in 50 CFR Section 402.02, include the effects of future state, Tribal, local, or private actions, not involving Federal activities, that are reasonably certain to occur within the action area (described in Section 1). Future Federal actions requiring separate consultations pursuant to Section 7 of the ESA are not considered here.

State, Tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water use patterns, including ownership and intensity, any of which could affect listed species or their habitat. Even actions that are already authorized are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities and many private landholdings, make any analysis of cumulative effects difficult and even speculative. This section identifies representative actions that, based on currently available information, are reasonably certain to occur. It also identifies goals, objectives and proposed plans by state and Tribal governments, however, NMFS is unable to determine at this point in time whether such proposals will in fact result in specific actions.

7.1 STATE ACTIONS

Regional

Each state in the Columbia River basin administers the allocation of water resources within its borders. Water resource development has slowed in recent years. Most arable lands have already been developed, the increasingly diversified regional economy has decreased demand, and there are increased environmental protections. If, however, substantial new water developments occur, cumulative adverse effects to listed fish are likely. NMFS cooperates with the state water resource management agencies in assessing water resource needs in the Columbia River basin. Through restrictions in new water developments, vigorous water markets may develop to allow existing developed supplies to be applied to the highest and best use. Interested parties have applied substantial pressure, including ongoing litigation, on the state water resource management agencies to reduce or eliminate restrictions on water development. It is, therefore, impossible to predict the outcomes of these efforts with any reasonable certainty.

In July 2000, the governors of Idaho, Montana, Oregon, and Washington released their "Recommendation for the Protection and Restoration of Fish in the Columbia River Basin," with the stated goal of "protection and restoration of salmonids and other aquatic species to sustainable and harvestable levels meeting the requirements of the Endangered Species Act, the Clean Water Act, the Northwest Power Act and tribal rights under treaties and executive orders while taking into account the need to preserve a sound economy in the Pacific Northwest." The recommendations include the following general actions:

1. **Habitat Reforms**
   a) Designate priority watersheds for salmon and steelhead.
   b) Provide local watershed planning assistance and develop the priority plans by October 1, 2002, and for all Columbia River basin watersheds by 2005.
   c) Integrate Federal, state, and regional planning processes with the NWPPC's amended Fish and Wildlife Program.
   d) Cooperate with Federal, Tribal, and local governments to implement the National Estuary Program for the lower Columbia River estuary, including creation of salmon sanctuaries.
2. **Harvest Reforms**
   a) Research the use of more selective fishing techniques and a license buyback program.
   b) Increase harvest selectivity through restrictions of harvest rates, gear, and timing for commercial and non-Treaty sport fisheries, consistent with ensuring survival of the species when combined with other recovery actions.
   c) Establish terminal fisheries below Bonneville Dam and in zone 6.
   d) Strengthen state law enforcement programs and coordinate them with habitat strategies to aid specific watersheds.
   e) Increase fishing opportunities for species that prey on, and compete with, salmon for food.
3. **Hatchery Reforms**
   a) Implement reforms recommended in the NWPPC's 1999 Artificial Production Review Report to congress.
   b) Support the region's fish managers and the Tribes' development of a comprehensive supplementation plan that includes intensive monitoring and evaluation.
   c) Mark hatchery fish that pose threats to listed fish, consistent with the Pacific Salmon Treaty.
4. **Funding and Accountability**
   a) Seek funding assistance for existing activities designed to improve ecosystem health and fish and wildlife health and protection.
   b) Work regionally to create a standardized and accessible information system to document regional recovery progress.

If these recommendations are implemented by the states individually and collectively, they should have beneficial effects on listed species and their habitat.

Oregon

Most future actions by the state of Oregon are described in the Oregon Plan for Salmon and Watershed measures, which includes the following programs designed to benefit salmon and watershed health:

- Oregon Department of Agriculture water quality management plans
- Oregon Department of Environmental Quality development of total maximum daily loads (TMDLs) in targeted basins; implementation of water quality standards

- Oregon Watershed Enhancement Board funding programs for watershed enhancement programs, and land and water acquisitions
- ODFW and Oregon Water Resources Department (OWRD) programs to enhance flow restoration
- OWRD programs to diminish over-appropriation of water sources
- ODFW and Oregon Department of Transportation programs to improve fish passage; culvert improvements/replacements
- Oregon Department of Forestry state forest habitat improvement policies and the Board of Forestry pending rules addressing forestry effects on water quality and riparian areas
- Oregon Division of State Lands and Oregon Parks Department programs to improve habitat health on state-owned lands
- Department of Geology and Mineral Industries program to reduce sediment runoff from mine sites
- State agencies funding local and private habitat initiatives; technical assistance for establishing riparian corridors; and TMDLs

If the foregoing programs are implemented, they may improve habitat features considered important for the listed species. In November 2000, however, Oregon voters approved a broad constitutional amendment requiring payment to private property owners for diminution in property values resulting from regulations. That measure essentially puts all Oregon regulatory initiatives into question. The Oregon Plan also identifies private and public cooperative programs for improving the environment for listed species. The success and effects of such programs will depend on the continued interest and cooperation of the parties. One such cooperative program, the Willamette Restoration Initiative (WRI), has been charged with developing the Willamette basin section of the Oregon Plan. The future of the WRI will be subject to discussion among the WRI board, the Oregon governor's office, and the Oregon legislature in the 2001 legislative session.

Washington

The state of Washington has various strategies and programs designed to improve the habitat of listed species and assist in recovery planning. Washington's 1998 Salmon Recovery Planning Act provided the framework for developing watershed restoration projects and established a funding mechanism for local habitat restoration projects. It also created the Governor's Salmon Recovery Office to coordinate and assist in the development of salmon recovery plans. Washington's "Statewide Strategy to Recover Salmon," for example, is designed to improve watersheds.

The Watershed Planning Act, also passed in 1998, encourages voluntary planning by local governments, citizens, and Tribes for water supply and use, water quality, and habitat at the Water Resource Inventory Area or multi-Water Resource Inventory Area level. Grants are made available to conduct assessments of water resources and to develop goals and objectives for future water resources management. The Salmon Recovery Funding Act established a board to localize salmon funding. The board will deliver funds for salmon recovery projects and activities based on a science-driven, competitive process. These efforts, if developed into actual programs, should help improve habitat for listed species.

Washington's Department of Fish and Wildlife and tribal comanagers have been implementing the Wild Stock Recovery Initiative since 1992. The comanagers are completing comprehensive species management plans that examine limiting factors and identify needed habitat activities. The plans also concentrate on actions in the harvest and hatchery areas, including comprehensive hatchery planning. The department and some western Washington treaty Tribes have also adopted a wild salmonid policy to provide general policy guidance to managers on fish harvest, hatchery operations, and habitat protection and restoration measures to better protect wild salmon runs.

Washington State's Forest and Fish Plan may be promulgated as administrative rules. The rules are designed to establish criteria for non-Federal and private forest activities that will improve environmental conditions for listed species. The Washington legislature may amend the Shoreline Management Act, giving options to local governments for complying with endangered species requirements in marine areas.

The state is also establishing the Lower Columbia Fish Recovery Board to begin drafting recovery plans for the lower Columbia region. The future impacts of the board's efforts will depend on legislative and fiscal support. The Washington Department of Transportation is considering changing its construction and maintenance programs to diminish effects on stream areas and to improve fish passage. The program may qualify for a limit under NMFS' 4(d) rule to conserve listed species.

Water quality improvements will be proposed through development of TMDLs. The state of Washington is under a court order to develop TMDL management plans on each of its 303(d) water-quality-listed streams. It has developed a schedule that is updated yearly; the schedule outlines the priority and timing of TMDL plan development.

Washington State closed the mainstem Columbia River to new water rights appropriations in 1995. All applications for new water withdrawals are being denied based on the need to address ESA issues. The state established and funds a program to lease or buy water rights for instream flow purposes. This program was started in 2000 and is in the preliminary stages of public information and identification of potential acquisitions. These water programs, if carried out over the long term, should improve water quantity and quality in the state.

As with Oregon's state initiatives, Washington's programs are likely to benefit listed species if they are implemented and sustained.

Idaho

The Idaho Department of Environmental Quality will establish TMDLs in the Snake River basin, a program regarded as having positive water quality effects. The TMDLs are required by court order, so it is reasonably certain that they will be set. However, the same agency is considering relaxing other water quality standards in Idaho streams, which could have negative effects on water quality.

The state of Idaho has created an Office of Species Conservation to work on subbasin planning and to coordinate the efforts of all state offices addressing natural resource issues. The state actions targeted by this office include the following:

1. Continue diversion screening, in cooperation with BPA and BOR
2. Improve flow augmentation for fish passage through state programs
3. Implement the Forest Practices Act to maintain forest tree species, soil, air, and water resources and provide a habitat for wildlife and aquatic life.
4. Complete cumulative watershed effects assessments on more than 100 watersheds to support watershed planning.
5. Require 30-foot buffers along Class II streams.

These state-directed actions, if continued, will have positive effects for listed species and their habitat.

Demands for Idaho's groundwater resources have caused groundwater levels to drop and reduced flow in springs for which there are senior water rights. The Idaho Department of Water Resources has begun studies and promulgated rules that address water right conflicts and demands on a limited resource. The studies have identified aquifer recharge as a mitigation measure with the potential to affect the quantity of water in certain streams, particularly those essential to listed species.

Montana

Montana is expected to undertake the following future state actions to benefit listed species in the Columbia River basin.

Under the State Water Quality Act, the Montana Department of Environmental Quality (MDEQ) is required to ensure that water quality restoration plans and permits are developed by 2007 for all waters on the 303 (d) list and within 10 years for any new water body added to the list. As part of the water quality restoration process, MDEQ and other agencies may provide financial grants to local water quality groups to implement pollution control measures. For non-point pollution sources, MDEQ plans to provide technical and financial support to local and regional watershed groups and allow them to take the lead in monitoring, developing plans, and implementing pollution controls. MDEQ's Remediation Division identifies water quality problems related to mining or other sources and coordinates cleanups with other resource management activities. This action may be part of a watershed restoration project carried out by local authorities.

Montana is implementing a new TMDL program to assess the quality of its water bodies and systematically implement water quality plans to restore and protect them. The plan calls for developing TMDLs for each of the 800 impaired water bodies on the 303 (d) list. Local watershed groups are asked to take responsibility for their own watersheds and work directly with MDEQ to develop TMDLs. These local watershed groups will also participate in the ranking and priority-setting process for watershed improvements to benefit listed species.

General

In the past, each state's economy depended on natural resources, with intense resource extraction. Changes in the states' economies have occurred in the last decade and are likely to continue, with less large-scale resource extraction, more targeted extraction, and significant growth in other economic sectors. Growth in new businesses, primarily in the technology sector, is creating urbanization pressures and increased demands for buildable land, electricity, water supplies, waste-disposal sites, and other infrastructure.

Economic diversification has contributed to population growth and movement in all four states, a trend likely to continue for the next few decades. Such population trends will result in greater overall and localized demands for electricity, water, and buildable land in the action area; will affect water quality directly and indirectly; and will increase the need for transportation, communication, and other infrastructure. The impacts associated with these economic and population demands will probably affect habitat features such as water quality and quantity, which are important to the survival and recovery of the listed species. The overall effect will be negative, unless carefully planned for and mitigated.

Some of the state programs described above are designed to address these impacts. Oregon also has a statewide, land-use-planning program that sets goals for growth management and natural resource protection. Washington State enacted a Growth Management Act to help communities plan for growth and address the effects of growth on the natural environment. If the programs continue, they may help lessen the potential for the adverse effects discussed above.

7.2 LOCAL ACTIONS

Local governments will be faced with similar and more direct pressures from population growth and movement. There will be demands for intensified development in rural areas, as well as increased demands for water, municipal infrastructure, and other resources. The reaction of local governments to growth and population pressure is difficult to assess without certainty in policy and funding. In the past, local governments in the three states generally accommodated growth in ways that adversely affected listed fish habitat. Because there is little consistency among local governments regarding current ways of dealing with land use and environmental issues, both positive and negative effects on listed species and their habitat are probably scattered throughout the action area.

In both Oregon and Washington, local governments are considering ordinances to address effects on aquatic and fish habitat from different land uses. The programs are part of state planning structures; however, local governments in Oregon are likely to be cautious about implementing new programs, because of the passage of the constitutional amendment discussed above. Some local government programs, if submitted, may qualify for a limit under NMFS' 4(d) rule, which is designed to conserve listed species. Local governments may also participate in regional watershed health programs, although political will and funding will determine participation and, therefore, the effect of such actions on listed species. Overall, unless beneficial programs are comprehensive, cohesive, and sustained in their application, it is not likely that local actions will have measurable positive effects on listed species and their habitat and may even contribute to further degradation.

7.3 TRIBAL ACTIONS

Tribal governments will participate in cooperative efforts involving watershed and basin planning designed to improve aquatic and fish habitat. The results of changes in Tribal forest and agricultural practices, in water resource allocation, and in land use are difficult to assess, for the reasons discussed in Sections 7.1 and 7.2. The earlier discussion of the effects of economic diversification and growth applies also to Tribal government actions. The Tribal governments have to apply and sustain comprehensive and beneficial natural resource programs such as the ones described below, to areas under their jurisdiction to have measurable positive effects on listed species and their habitat.

One Tribal program illustrates future Tribal actions that should have such positive effects. The *Wy-Kan-Ush-Mi Wa-Kish-Wit*, or "Spirit of the Salmon" plan is a joint restoration plan for anadromous fish in the Columbia River basin prepared by the Nez Perce, Umatilla, Warm Springs and Yakama Tribes. It provides a framework for restoring anadromous, or sea-going, fish stocks, specifically salmon, Pacific lamprey (eels), and white sturgeon in upriver areas above Bonneville Dam. The plan's objectives are as follows:

1. Halt the decline of salmon, lamprey, and sturgeon populations above Bonneville Dam within 7 years.
2. Rebuild salmon populations to annual run sizes of 4 million above Bonneville Dam within 25 years in a manner that supports Tribal ceremonial, subsistence, and commercial harvests.
3. Increase lamprey and sturgeon to naturally sustaining levels within 25 years in a manner that supports Tribal harvests.

The plan emphasizes strategies and principles that rely on natural production and healthy river systems. The plan's technical recommendations cover hydro operations on the mainstem Columbia and Snake rivers; habitat protection and rehabilitation in the basin above Bonneville Dam, in the Columbia estuary, and in the Pacific ocean; fish production and hatchery reforms; and inriver and ocean harvests.

The Nez Perce, Warm Spring, Umatilla, and Yakama Tribal governments are now seeking to implement this plan and salmon restoration in conjunction with the states, other Tribes, and the Federal government, as well as in cooperation with their neighbors throughout the basin's local watersheds and with other citizens of the Northwest.

Overall, the Spirit of the Salmon plan should have positive cumulative effects on listed species and their habitat.

7.4 PRIVATE ACTIONS

The effects of private actions are the most uncertain. Private landowners may convert their lands from current uses, or they may intensify or diminish those uses. Individual landowners may voluntarily initiate actions to improve environmental conditions, or they may abandon or resist any improvement efforts. Their actions may be compelled by new laws, or they may result from growth and economic pressures. Changes in ownership patterns will have unknown impacts. Whether any of these private actions will occur is highly unpredictable, and the effects are even more so.

7.5 SUMMARY

Non-Federal actions are likely to continue affecting listed species. The cumulative effects in the action area are difficult to analyze, considering the broad geographic landscape covered by this opinion, the geographic and political variation in the action area, the uncertainties associated with government and private actions, and ongoing changes to the region's economy. Whether those effects will increase or decrease in the future is a matter of speculation; however, based on the population and growth trends identified in this section, cumulative effects are likely to increase. Although state, Tribal, and local governments have developed plans and initiatives to benefit listed salmon and steelhead, they must be applied and sustained in a comprehensive manner before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

8.0 CONCLUSIONS

The analysis in the preceding sections of this biological opinion forms the basis for conclusions as to whether the proposed action, the ongoing operation of the FCRPS, and the BOR projects identified in Table 1.0-1 satisfy the standards of ESA Section 7(a)(2). To do so, the Action Agencies must ensure that their proposed action is not likely to jeopardize the continued existence of any listed species or destroy or adversely modify the designated critical habitat of such species. Section 4 of this opinion defines the biological requirements and the current status of each of the 12 listed salmonid species. Section 5 evaluates the relevance of the environmental baseline to each species' current status. Section 6 details the likely effects of the proposed action, both on individuals of the species in the action area and on the listed population as a whole, across its range and life cycle. Section 7 considers the cumulative effects of relevant non-Federal actions reasonably certain to occur within the action area. On the basis of this information and analysis, NMFS draws its conclusions about the effects of the FCRPS and the BOR projects on the survival and recovery of the 12 listed salmonid species.

As discussed in Section 1.3 of this biological opinion, NMFS must now determine "whether the species can be expected to survive with an adequate potential for recovery under the effects of the proposed or continuing action, the environmental baseline and cumulative effects, and considering measures for survival and recovery specific to other life stages." The information available to NMFS for this determination is both quantitative and qualitative. For some species, such as SR spring/summer chinook salmon, the available information includes substantial quantitative data based on empirical observations. For other species, such as SR sockeye salmon, the available information is largely qualitative, based on the best professional judgment of knowledgeable scientists. Despite an increasing trend toward a more quantitative understanding of the critical life signs for these fish, critical uncertainties limit NMFS' ability to project future conditions and effects. As a result, no hard and fast numerical indices are available for any of these stocks on which NMFS can base determinations about jeopardy or the adverse modification of critical habitat (the Section 7(a)(2) standards). Ultimately, for all 12 ESUs, NMFS' conclusions are qualitative judgments based on the best quantitative and qualitative information available for each species.

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8.1 SNAKE RIVER SPRING/SUMMER CHINOOK SALMON

8.1.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this stream-type salmonid, which migrates to the ocean as a yearling and spawns and rears in tributaries upstream of the FCRPS, are not being met, either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of this species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with current prospects for survival and recovery across the range and life cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include substantial ongoing juvenile and adult mortality associated with dam and reservoir passage and high TDG levels during periods of involuntary spill. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

At the species level, Table 6.3-12 indicates that at least 2%, and up to 33%, survival improvements are needed for 80% of index stocks to meet the indicator criteria. Substantial survival improvements, in addition to those likely to result from the proposed action and other measures for survival and recovery that affect other life stages, are required to ensure a high likelihood of survival and a moderate-to-high likelihood of recovery for the other spawning aggregates within this ESU. Some portion of additional survival improvement may result from ongoing Federal conservation efforts to improve habitat and hatchery practices identified in the basinwide strategy. The degree to which these Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of SR spring/summer chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.1.2 NMFS' Issuance of Section 10 Transportation Permit

After reviewing the current status of SR spring/summer chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action (particularly those described in Sections 6.2.3 and 6.2.8), and cumulative effects, NMFS concludes that the issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.2 SNAKE RIVER FALL CHINOOK SALMON

8.2.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this ocean-type salmonid, which outmigrates as a subyearling and both spawns and rears in the action area, are not met either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of the species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with current prospects for survival and recovery across the range and life cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include substantial ongoing juvenile and adult mortality associated with dam and reservoir passage, and high TDG levels during periods of involuntary spill. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

At the species level, Table 6.3-12 indicates that substantial survival improvements (6% to 64%), in addition to those likely to result from the proposed action and other measures for survival and recovery that affect other life stages are required to ensure a high likelihood of survival and a moderate-to-high likelihood of recovery for this ESU. Some portion of additional survival improvement may result from ongoing Federal conservation efforts to improve habitat and hatchery practices identified in the basinwide strategy. The degree to which Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of SR fall chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.2.2 NMFS' Issuance of Section 10 Transportation Permit

After reviewing the current status of SR fall chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action (particularly those described in Sections 6.2.3 and 6.2.8), and cumulative effects, NMFS concludes that issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.3 UPPER COLUMBIA RIVER SPRING CHINOOK SALMON

8.3.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this stream-type salmonid, which outmigrates as a yearling and both spawns and rears in tributaries upstream of the FCRPS, are not being met either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of this species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with current prospects for survival and recovery across the range and life cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

The key effects on this species in the action area are summarized in Section 6.2.9. The effects include juvenile and adult mortality associated with dam and reservoir passage, and high TDG levels during involuntary spill. Juvenile and adult mortality in the action area is still substantial. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

At the species level, Table 6.3-12 indicates that substantial survival improvements (at least 45%), in addition to those likely to result from the proposed action and other measures for survival and recovery that affect other life stages, are required to ensure a high likelihood of survival and a moderate-to-high likelihood of recovery for this ESU. Some portion of additional survival improvement may result from ongoing Federal conservation efforts to improve habitat and hatchery practices, identified in the basinwide strategy. The degree to which these Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of UCR spring chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.3.2 NMFS' Issuance of Section 10 Transportation Permit

Only a small part of this population is affected by summer transportation from McNary Dam. After reviewing the current status of UCR spring chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.4 UPPER WILLAMETTE RIVER CHINOOK SALMON

8.4.1 Proposed BPA, Corps, and BOR Action

Salmonids in this ESU spawn and rear in tributaries that enter the Columbia River downstream of all FCRPS dams. The only effects of FCRPS operation on this ESU are potential degradations of habitat in the estuary and plume. The extent of these effects is uncertain and appears to be minor, compared with other factors influencing the status of this species (Table 6.3-13). After reviewing the current status of UWR chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.4.2 NMFS' Issuance of Section 10 Transportation Permit

UWR chinook salmon will not be affected by issuance of a Section 10 permit.

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8.5 LOWER COLUMBIA RIVER CHINOOK SALMON

8.5.1 Proposed BPA, Corps, and BOR Action

As discussed in Section 6.2, this ESU is distributed primarily in spawning and rearing areas below Bonneville Dam. Within the action area, the key effects on this species are summarized in Section 6.2.9. Effects of the FCRPS include passage mortality of juveniles and adults through one dam and reservoir for a limited number of subbasin populations. For the small portion of the ESU that spawns in the Ives Island area below Bonneville Dam, access to, and quantity and quality of, that spawning habitat can be affected by FCRPS flow regulation. At the species level, however, this ESU has multiple populations within the Columbia River basin, most of which are below FCRPS projects.

Per USFWS and NMFS' implementing regulations, adverse effects on constituent elements of critical habitat generally do not result in a determination of "adverse modification" unless that loss, when added to the environmental baseline, is likely to appreciably diminish the value of that critical habitat for both the survival and recovery of the listed species (50 CFR Sec. 402.02). As discussed in Section 4.1.5 and Appendix C, the principal factors for decline and existing bottlenecks to recovery of LCR chinook salmon are as follows:

- A pervasive influence of hatchery fish on most natural populations, including both spring- and fall-run populations
- Timber harvesting and associated road building, agriculture, and urbanization that have affected riparian vegetation, stream hydrology, and water quality in tributary spawning areas
- Access to substantial spawning habitat that has been blocked (or passage is substantially impaired) in the Cowlitz (Mayfield Dam), Lewis (Merwin Dam), Clackamas (North Fork Dam), Hood (Powerdale Dam), and Sandy (Marmot and Bull Run River dams) rivers

Given this context, NMFS must determine whether mainstem spawning habitat is an essential requirement of LCR chinook salmon. Because tule chinook salmon have been observed spawning in the Ives Island complex only once (October 1999), the answer to this question depends on whether mainstem spawning was, historically, a significant characteristic of the ESU and, if so, whether mainstem spawners made up independent populations (or, whether they were closely associated with populations in the lower ends of adjacent tributaries). The Willamette/Lower Columbia River Technical Recovery Team will consider these issues. However, at the present time, NMFS knows of no evidence that mainstem spawning was, historically, a significant characteristic of the ESU.

After reviewing the current status of LCR chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, NMFS concludes that the proposed action is not likely to jeopardize the continued existence of LCR chinook salmon or to destroy or adversely modify its designated critical habitat.

8.5.2 NMFS' Issuance of Section 10 Transportation Permit

LCR chinook salmon will not be affected by issuance of a Section 10 permit.

8.6 SNAKE RIVER STEELHEAD

8.6.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this stream-type salmonid, which migrates to the ocean as a yearling and spawns and rears in tributaries upstream of the FCRPS, are not being met, either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of this species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with current prospects for survival and recovery across the range and life cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include substantial ongoing juvenile and adult mortality associated with dam and reservoir passage, and high TDG levels during periods of involuntary spill. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

At the species level, Table 6.3-12 indicates that substantial survival improvements (at least 56%), in addition to those likely to result from the proposed action and other measures for survival and recovery that affect other life stages, are required to ensure a high likelihood of survival and a moderate-to-high likelihood of recovery for this ESU. Some portion of additional survival improvement may result from ongoing Federal conservation efforts to improve habitat and hatchery practices identified in the basinwide strategy. The degree to which these Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of SR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.6.2 NMFS' Issuance of Section 10 Transportation Permit

After reviewing the current status of SR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action (particularly as described in Sections 6.2.3 and 6.2.8), and cumulative effects, NMFS concludes that issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify designated critical habitat.

8.7 UPPER COLUMBIA RIVER STEELHEAD

8.7.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this stream-type salmonid, which migrates to the ocean as a yearling and spawns and rears in tributaries upstream of the FCRPS, are not being met, either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of this species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with current prospects for survival and recovery across the range and life cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include substantial ongoing juvenile and adult mortality associated with dam and reservoir passage and high TDG levels during periods of involuntary spill. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

At the species level, Table 6.3-12 indicates that substantial survival improvements (at least 17% to as high as 146%), in addition to those likely to result from the proposed action and other measures for survival and recovery that affect other life stages, are required to ensure a high likelihood of survival and a moderate-to-high likelihood of recovery for this ESU. Some portion of additional survival improvement may result from ongoing Federal conservation efforts to improve habitat and hatchery practices identified in the basinwide strategy. The degree to which these Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of UCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.7.2 NMFS' Issuance of Section 10 Transportation Permit

Only a small part of this population is affected by summer transportation from McNary Dam. Therefore, after reviewing the current status of UCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action (particularly as described in Sections 6.2.3 and 6.2.8), and cumulative effects, NMFS concludes that issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.8 MIDDLE COLUMBIA RIVER STEELHEAD

8.8.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this stream-type salmonid, which migrates to the ocean as a yearling and spawns and rears in tributaries upstream of the FCRPS, are not being met, either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of this species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with current prospects for survival and recovery across the range and life cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include substantial ongoing juvenile and adult mortality associated with dam and reservoir passage and high TDG levels during periods of involuntary spill. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

At the species level, Table 6.3-12 indicates that substantial survival improvements (at least 130%), in addition to those likely to result from the proposed action and other measures for survival and recovery that affect other life stages, are required to ensure a high likelihood of survival and a moderate-to-high likelihood of recovery for this ESU. This assessment is based on the similarity of the action's effects on UCR and MCR steelhead and the current status of MCR steelhead, which are at greater risk of extinction than UCR steelhead for the largest population whose risk can be assessed. Some portion of additional survival improvement may result from ongoing Federal conservation efforts to improve habitat and hatchery practices, identified in the basinwide strategy. The degree to which these Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of MCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.8.2 NMFS' Issuance of Section 10 Transportation Permit

Only a small part of this population is affected by summer transportation from McNary Dam. After reviewing the current status of MCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action (particularly as described in Sections 6.2.3 and 6.2.8), and cumulative effects, therefore, NMFS concludes that issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.9 UPPER WILLAMETTE RIVER STEELHEAD

8.9.1 Proposed BPA, Corps, and BOR Action

This ESU spawns and rears in tributaries that enter the Columbia River downstream of all FCRPS projects. The only effects of FCRPS operation on this ESU are potential habitat degradations in the estuary and plume. The extent of these effects is uncertain and appears to be minor, compared with other factors influencing the status of this species (Table 6.3-13).

After reviewing the current status of UWR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.9.2 NMFS' Issuance of Section 10 Transportation Permit

UWR chinook salmon will not be affected by issuance of a Section 10 permit.

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8.10 LOWER COLUMBIA RIVER STEELHEAD

8.10.1 Proposed BPA, Corps, and BOR Action

Key effects on this species in the action area, summarized in Section 6.2.9, include passage mortality of juveniles and adults through one dam and reservoir for spawning aggregations in a few subbasins. NMFS' quantitative evaluation of the effects of the proposed action and other ongoing Federal actions on this ESU's species-level biological requirements indicates a slight increase in the median annual population growth rate for summer steelhead in the Clackamas and Kalama subbasins due to recent harvest limitations on A-run steelhead (Table 6.3-10). For most of the spawning aggregations in this ESU, factors other than the FCRPS contributed to their decline and now limit their potential for survival and recovery (Table 6.3-13). After reviewing the current status of LCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

8.10.2 NMFS' Issuance of Section 10 Transportation Permit

LCR steelhead will not be affected by issuance of a Section 10 permit.

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8.11 COLUMBIA RIVER CHUM SALMON

8.11.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this ocean-type salmonid, which outmigrates as a subyearling and both spawns and rears in tributaries upstream from the FCRPS and in the mainstem Columbia River, are not being met either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, individuals of this species are subjected to adverse effects on spawning and rearing habitat in the Hamilton/Hardy creeks/Ives Island complex below Bonneville Dam that result in their mortality or impaired fitness. Continuing the proposed action for the long term, coupled with the current prospects for survival and recovery across the range and life-cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include adverse effects of flow management on access to Hamilton Creek, Spring Creek, and the Ives Island spawning areas. The quantity and quality of habitat at the Ives Island spawning area are also adversely affected by FCRPS flow management. In contrast to the situation for LCR chinook, this ESU spawns in only two areas, meaning that FCRPS effects on habitat in one of these areas significantly affect the entire ESU. NMFS' quantitative evaluation of the effects of the proposed action and other ongoing Federal actions on this ESU's species-level biological requirements does not indicate any expected change in the median annual population growth rate (Table 6.3-11).

Ongoing Federal conservation efforts to improve habitat and hatchery practices, identified in the basinwide strategy, may improve survival rates. The degree to which these Federal survival and recovery measures will sufficiently improve the ESU's condition is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of CR chum salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.11.2 NMFS' Issuance of Section 10 Transportation Permit

CR chum salmon will not be affected by issuance of a Section 10 permit.

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8.12 SNAKE RIVER SOCKEYE SALMON

8.12.1 Proposed BPA, Corps, and BOR Action

The biological requirements of this stream-type salmonid, which migrates to the ocean as a yearling and spawns and rears in lakes upstream of the FCRPS, are not being met either in the FCRPS action area or at the life-cycle level. As discussed in Section 6.2, when passing through the FCRPS, individuals of this species are subjected to adverse habitat conditions that cause mortality or result in impaired fitness. Although recent improvements in the operation and configuration of the FCRPS have reduced overall mortality rates for the species, current survival through the FCRPS, as affected by operation of the BOR projects, is not sufficient to ensure the survival of the ESU with an adequate potential for recovery. Instead, continuing the proposed action for the long term, coupled with the current prospects for survival and recovery across the range and life-cycle of the ESU, is likely to appreciably reduce the likelihood of both its survival and its recovery.

Key effects of the proposed action on this species in the action area are summarized in Section 6.2.9. They include substantial ongoing juvenile and adult mortality associated with dam and reservoir passage and TDG gas levels during periods of involuntary spill. Although the proposed action describes a process to develop performance standards for actions that would reduce mortality, it is not clear that mortality will be reduced enough or that critical habitat will be adequately protected.

Because the abundance of this ESU is so low, NMFS cannot perform a quantitative assessment of species-level effects of the proposed action and other ongoing Federal actions. However, the ongoing level of risk to this ESU is extremely high and it is likely to remain so if the proposed action continues. The captive breeding program provides short-term protection from extinction, but it is not sufficient to avoid extinction in the future. Some additional improvement in species status may result from ongoing Federal conservation efforts to improve habitat and hatchery practices, described generally in the basinwide strategy. The degree to which these Federal survival and recovery measures will sufficiently augment the survival improvements expected from the proposed action is, however, highly uncertain. NMFS must also rely on progress in implementing non-Federal survival and recovery measures that affect other life stages. Furthermore, NMFS finds that survival improvements beyond those likely to result from the proposed action are reasonably available to the FCRPS Action Agencies. After reviewing the current status of SR sockeye salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action, and cumulative effects, therefore, NMFS concludes that the proposed operation and configuration of the FCRPS and the BOR projects are likely to jeopardize the continued existence of this ESU and to adversely modify its designated critical habitat.

8.12.2 NMFS' Issuance of Section 10 Transportation Permit

After reviewing the current status of SR sockeye salmon and the factors for its decline, the environmental baseline in the action area, the effects of the proposed action (particularly Sections 6.2.3 and 6.2.8), and cumulative effects, NMFS concludes that issuance of a Section 10 transportation permit, as proposed, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

9.0 REASONABLE AND PRUDENT ALTERNATIVE

9.1 OVERVIEW OF THE ALTERNATIVE

This RPA for the FCRPS and for BOR's 19 projects, including the entire Columbia Basin project, identifies actions that, combined with other ongoing and anticipated measures in the Columbia River basin outlined in the Basinwide Recovery Strategy,[1] are likely to ensure a high likelihood of survival with a moderate-to-high likelihood of recovery for each of the listed species. Based on the best available scientific information, the following fundamental components of the RPA would allow the FCRPS to avoid jeopardizing the continued existence of the listed species or adversely modifying their critical habitat.

9.1.1 Performance Standards

The RPA defines certain performance standards that will meet the jeopardy standard described in Section 1.3.1.1 now and as it is fully implemented by 2010. Performance standards for this RPA, described in Section 9.2, are derived from biological requirements of the listed populations as a whole. As the Basinwide Recovery Strategy explains, performance standards are defined at three tiers. At the most general tier are the population-level performance standards. These state the performance needed for the listed population to achieve an adequate likelihood of survival and recovery. Life-stage-specific performance standards at the intermediate tier allocate the performance expectations needed across the life cycle to achieve the population level performance standards. This tier guides the determination of performance standards for particular categories of actions in habitat, harvest, hatcheries, and hydro, at the next level, such as performance standards for hydropower in this RPA. These third-tier standards are applicable to all activities of this type and are intended to achieve the life-stage-specific performance standards.

At the population level, performance will be evaluated in terms of population growth rate, abundance, genetic diversity, life history diversity, and geographic distribution. NMFS will apply these principles to the listed ESUs in the basin through its recovery planning process, which will include developing specific goals and measures for each ESU within 3 years.

Hydrosystem performance standards include specific adult and juvenile survival levels (direct and indirect) expected to result from implementing the best or most intensive actions that NMFS and the Action Agencies agree are biologically and technically feasible and within the authority

[1] NMFS is issuing the "Conservation of Columbia Basin Fish: Final Basinwide Salmon Recovery Strategy" (hereinafter the Basinwide Recovery Strategy). This document outlines the expected improvements in hydro, habitat, hatcheries, and harvest needed to meet the goals of the ESA at the same time as this biological opinion. The Basinwide Recovery Strategy is a conceptual recovery plan that NMFS intends to use as a guideline for evaluating actions that affect the listed species. Consistency with the Basinwide Recovery Strategy ensures that actions are both avoiding jeopardy and enabling the recovery of listed species.

of the Action Agencies. The Action Agencies are committed to attaining the hydro standards by 2010. Sections 6.1.1, 9.7.1, and Appendix D describe how the hydro performance standards were derived.

Offsite mitigation standards include the implementation of specific measures identified in the Basinwide Recovery Strategy and in Sections 9.6.2, 9.6.3, and 9.6.4. The Action Agencies are committed to implementing the offsite mitigation measures described in these sections. The Basinwide Recovery Strategy describes the level of additional improvements to be attained through actions that address other life stages (including, but not limited to, improvements made through offsite mitigation by the FCRPS Action Agencies).

9.1.2 Hydro Actions

Section 9.6.1 of this RPA describes a set of specific, hydro actions that NMFS has determined, on the basis of available scientific information, will achieve the FCRPS hydro performance standards. Most of the measures are aimed at improving passage survival through FCRPS dams and reservoirs by changing project operations and improving project configuration. The measures include the following:

1. Enhanced spill and spillway improvements to facilitate higher spill levels without exceeding harmful TDG levels

2. Improved flow management

3. Physical improvements to both juvenile and adult fish passage facilities

4. Increased use of barges and less reliance on trucks to transport summer migrants

5. Continuation of spill at collector projects to maximize the survival rate of inriver migrants

As determined through the planning process described in Section 9.4, NMFS may deem other combinations of measures sufficient to meet the performance standards and avoid jeopardy.

9.1.3 Offsite Mitigation Actions

Additional measures call for offsite mitigation, as discussed in Sections 9.6.2, 9.6.3, and 9.6.4. These additional actions are included to improve the productivity of the listed salmon populations beyond what would be possible through hydro actions alone. Even with survival improvements in fish passage at and between dams, significant mortality associated with FCRPS/BOR operations will continue to occur. NMFS, therefore, advises the Action Agencies that additional offsite mitigation for habitat, hatcheries, and harvest is needed to avoid jeopardy.

Action Agency implementation of measures in these other areas will increase the certainty and reliability of attaining the increased survival rate of listed ESUs.

Offsite mitigation provided by the Action Agencies will not preclude the need for improvements in habitat, hatcheries, and harvest by other Federal or Non-Federal parties, nor will it diminish the obligation of these other parties to seek improvements in furtherance of Section 7(a)(1) or Section 7(a)(2). Offsite mitigation is intended to complement, not displace, actions by other entities to address habitat, hatcheries, and harvest. Where there are overlaps between offsite mitigation activities of the Action Agencies and the responsibilities of other Federal and non-Federal entities, costs and implementation responsibilities will be shared and coordinated as appropriate.

9.1.4 Rolling 1- and 5-Year Plans

An annual, multiyear planning process to refine, implement, evaluate, and adjust ongoing efforts is critical to achieving the FCRPS hydro and offsite performance standards within the time frame covered by this biological opinion. This will be accomplished through development and implementation of 1- and 5-year plans to achieve both hydro performance standards and offsite mitigation performance standards. The plans will cover all operations, configuration, research, monitoring, and evaluation actions. The plans will also describe habitat, hatchery and harvest actions to be funded or otherwise carried out by the Action Agencies as offsite mitigation. The RPA allows for revision of the specific measures throughout its term, as long as the Action Agencies make steady progress toward meeting performance standards and remain on track for full attainment of the hydro standards by 2010. The 2003 annual plan will contain a comprehensive assessment of the success of the action agencies in obtaining the funding and authorizations and in further defining and implementing the actions called for in this RPA. NMFS will reinitiate consultation if there is lack of adequate progress at that time or in subsequent reviews. The annual planning process is outlined in Section 9.4.

9.1.5 Comprehensive 3-, 5-, and 8-Year Check-ins

Any assessment of future conditions presents the risk that the actions identified under this RPA will not be adequate to ensure long-term survival of the listed ESUs. To manage that risk, NMFS has included critical monitoring, evaluation, and performance measures, as well as action levels, to trigger additional measures if needed. The region must be prepared to move forward with these alternative measures, given the possibility that onsite and offsite measures will not have the predicted results, or that subsequent information will show the predicted improvements to be inadequate. Section 9.2 describes the performance standards and measures. Section 9.5 describes the steps for review and decision-making regarding the adequacy and effectiveness of the RPA. This RPA calls for annual progress reports; major progress evaluations in 2003, 2005, and 2008; and pursuit of other ways to avoid jeopardy in the future, including possible breaching of dams if necessary.

Another key element of the annual progress evaluations in 5 and 8 years is progress on resolving critical uncertainties. Resolution of critical uncertainties is necessary to assess progress, as described above, and to provide guidance on pending actions.

9.1.6 Monitoring, Evaluation, and Progress Reporting

Monitoring and evaluation is not merely the periodic collection of data. Rather, properly designed monitoring programs will provide data for resolving a wide range of uncertainties, including determining population status, establishing causal relationships between habitat (or other) attributes and population response, and assessing the effectiveness of management actions. The information gained through monitoring programs will be a cornerstone in identifying alternative actions and refining recovery efforts. Such programs are, therefore, critical to the successful implementation of this RPA.

For example, there is considerable uncertainty even in assessing the status of listed ESUs under current conditions. It is quite apparent that extinction risks were high under the baseline conditions that led to their listing, and they appear to remain quite high under current conditions. However, precisely quantifying population trends of wild, listed fish depends on knowing the proportion of observed fish that are hatchery fish spawning naturally, and the relative reproductive success of those fish. This information, particularly the latter point, is largely lacking. As a result, the range of uncertainty associated with NMFS' current estimates of risk is large. Recently many artificial production reforms, designed to reduce negative effects of hatchery production on natural populations while retaining its proven production and potential conservation benefits, have been implemented. An important component of any monitoring program will, therefore, be documenting the results and benefits from these recent and ongoing reforms while resolving population status.

In addition, despite full use of the best science available, substantial uncertainty remains about the effectiveness of measures available to meet the biological requirements of listed ESUs. In hydro, for example, the projected effect of the hydro measures, or of the alternative of breaching dams, depends largely on the degree to which there is delayed mortality associated with juvenile fish passage at those dams, either inriver or with barge transportation, and the degree to which that delayed effect would be mitigated with breaching of any particular dam or dams. The potential for delayed, pre-spawning mortality of adults and for survival effects related to estuary or plume conditions created through water management practices are also highly critical uncertainties. In habitat, critical uncertainties are associated with the feasibility of implementing protective measures in light of the existing institutional frameworks (e.g., addressing in-stream flow needs in over-appropriated streams). Uncertainty also exists concerning the magnitude of the expected biological response to habitat actions that achieve their physical objectives and the time frame for that biological response. In the area of artificial propagation, scientific knowledge regarding the effectiveness of hatchery supplementation as a means of speeding recovery is incomplete, but improving, as is the impact of hatchery supplementation on wild populations. Artificial production measures have proven effective in many cases at alleviating near-term extinction risks, yet the potential long-term benefits of artificial production as a recovery measure are unclear.

To resolve these uncertainties, specific scientific studies must be undertaken with rigorous monitoring and evaluation, focusing on determining population status and the mechanisms that regulate salmon populations. The results from these studies and monitoring should provide better understanding about the status of the ESUs, about which measures work, and about which measures do not work. NMFS also requires monitoring and evaluation of measures to assess an Action Agency's progress in implementing its RPA and the benefits resulting from the Action Agency's implementation. The RPA establishes a schedule of measures, milestones, standards, and decisions subject to updating and refinement through annual planning, to ensure that this evaluation process is disciplined and rigorous. Progress on resolving these uncertainties will be a primary consideration in the annual and 5-year planning process as well as in the 3-, 5-, and 8-year check-ins. Monitoring and evaluation may lead to revisions in measures the Action Agencies undertake to meet performance standards, or in the performance standards themselves, to ensure that the overall program is sufficient to avoid jeopardy to listed ESUs.

9.1.7 Advance Planning for Breach or Other Additional Actions

NMFS has given significant consideration to the options involving breach of the lower Snake River and possibly other dams. Generally, any action that removes or eliminates a source of adverse effects from the listed species' life cycle increases the odds that survival rates will improve. By reducing the effects of one type of human activity, breaching the four lower Snake River dams would provide more certainty of long-term survival and recovery than would other measures.

This RPA requires Action Agencies to take specific actions under certain circumstances to ensure that alternative approaches are available. Such actions will allow for the possibilities that the hydro and offsite mitigation actions described here will not provide the anticipated survival rate increases, or that subsequent information shows the predicted improvements are inadequate. Although the RPA does not rely on breach of any dams to avoid jeopardy, it does require further development of breach as an option if future conditions warrant it. NMFS recognizes that breach is a major action requiring NEPA compliance, congressional authorization, and appropriations before it can be implemented. The specific actions described in Section 9.6.1.9 will reduce the time needed to seek congressional authorization for breach and will reduce the time needed for possible implementation, thereby avoiding delay should breach become a preferred approach.

9.1.8 Breach Triggers

The RPA establishes a schedule for determining whether to pursue breach as a means of avoiding jeopardy. This schedule addresses possible breach of one or a combination of hydroelectric projects. The schedule provides for a rigorous mid-point review of progress in 2005, another comprehensive review in 2008, and a determination under certain conditions to pursue breach if

NMFS issues a failure report on the RPA following one of these reviews. The mid-point evaluation process is described in Section 9.5.

9.1.9 Independent Peer Review

It is important that the public and the courts have confidence in the Action Agencies' activities and in the science that supports the RPA. Accordingly, NMFS, working through the Regional Forum and the Independent Scientific Advisory Board, will obtain independent scientific review of its 5- and 8-year evaluation reports.

9.1.10 Immediate Actions and Benefits

Because listed Columbia River basin anadromous fish are in such fragile condition, an immediate focus on areas and measures that provide gains within 1 to 10 years is essential.

Section 9.6.1 describes the hydrosystem measures intended to provide these short-term gains. Section 9.7.1 describes the expected effects of those actions on juvenile and adult survival levels. The Action Agencies are committed to implementing the specified hydro measures and/or additional measures as needed to fully attain these system survival levels by 2010.

For offsite mitigation, the discussions of habitat (Section 9.6.2), harvest (Section 9.6.3), and hatcheries (Section 9.6.4) describe early action items designed to produce immediate improvements. For habitat these include restoring tributary flows, screening water diversions, providing passage at obstructions, and securing additional riparian, wetland, floodplain, intertidal, or shallow-water habitats. Short-term gains in hatcheries are expected through implementation of conservation hatchery safety nets and hatchery reform, as explained in Section 9.6.4. Given the status and trends of a number of populations in the upper Columbia River and the Snake River basins, the potential benefits of intervening with artificial production actions may outweigh the risks of such intervention. NMFS will work with the Action Agencies on a method for recognizing and documenting the benefits of these efforts. The offsite action items also allow for a thorough assessment of the overall strategic approach by the mid-point progress reviews.

9.2 PERFORMANCE STANDARDS

The purpose of this RPA is to establish a course of action for FCRPS and BOR operations that avoids both jeopardy to the listed stocks and destruction or adverse modification of critical habitat and, thus, meets the standards of ESA Section 7(a)(2). In this biological opinion, NMFS establishes performance standards and associated performance measures that will be used to evaluate the actions implemented each year and proposed in the 1- and 5-year plans.

The RPA is also a major component of the conceptual recovery plan in the Basinwide Recovery Strategy. The Action Agencies' implementation of the RPA will ensure that the FCRPS avoids jeopardy and adverse modification of critical habitat, because the agencies' actions, when added to the other components of the plan, will enable the survival and recovery of the listed salmon and steelhead species. Performance standards are central to the program and depend on clear objectives, measurable results, and accountability.

Performance standards for the RPA derive from the biological requirements of the listed populations at the life cycle level and at each life stage. As the Basinwide Recovery Strategy explains, performance standards are defined in three tiers. The most general tier is the population level performance standards. They define the performance needed for the listed population to achieve adequate likelihoods of survival and recovery. Life-stage-specific performance standards at the intermediate tier allocate across the life cycle the performance expectations necessary to achieve the population-level standards. This tier guides the development of performance standards for categories of actions in habitat, harvest, hatcheries, and hydropower in this RPA. The third-tier standards are intended to achieve the life-stage standards.

NMFS will apply the performance standards when determining whether implementation of the RPA continues to satisfy ESA standards. Because the action-level performance standards derive from the population-level and life-stage-specific performance standards, NMFS will look at all performance standards when making its determination in years 3, 5, and 8.

9.2.1 Programmatic Performance Standards

In years 3, 5, and 8, NMFS will assess whether the Action Agencies have implemented the program of hydro, habitat, and hatchery improvements and the research, monitoring, and evaluation necessary for continuing assessment described in this biological opinion as required to ensure consistency with ESA. Programmatic performance standards include the actions and the schedule defined in the biological opinion and the annual planning process. Performance is measured by the Action Agencies' success in implementing the actions defined in the RPA and annual plans. Critical actions to be evaluated at the 3-, 5-, and 8-year reviews are further described in Section 9.5 and Appendix F. Progress against this standard will be formalized in

NMFS' review of the annual progress reports prepared by the Action Agencies, in the annual NMFS findings letter, and in comprehensive 3-, 5-, and 8-year evaluations. Further information on the 1- and 5-year planning process can be found in Section 9.4.

9.2.2 Biological Performance Standards

Biological performance standards fall into two categories:

- Standards intended to evaluate the status of the stocks (relevant to the population-level and life-stage-specific performance standards)

- Standards intended to evaluate how effectively the actions produce an expected biological response (most relevant to the performance standards that apply to actions)

Both types of evaluation depend on a robust and comprehensive research, monitoring, and evaluation program. NMFS will assess the development and implementation of this research, monitoring, and evaluation program in years 3, 5, and 8. The standards for evaluating stock status and actions will be used in years 5 and 8, when effects should be discernable.

9.2.2.1 Standards Related to ESU Status

The standards used to evaluate stock status reflect the biological requirements of the ESUs consistent with maintaining a high likelihood of survival and a moderate-to-high likelihood of recovery. Recovery standards will ultimately include measures of abundance, productivity trends, species diversity, and population distribution. While recovery standards are being established, NMFS will assess the likelihood of survival and recovery based on estimates of life-stage survival increases and annual population growth rate (e.g., lambda) for each identifiable population in the ESU, as well as previously defined interim recovery goals (see Table 1.3-1). Lambda is derived from observed population abundance and reflects a stock's current productivity. Thus, it addresses important factors likely to be included in future recovery standards.

Estimates of lambda used in this biological opinion were generated using standard techniques (McClure et al. 2000b). The estimates and techniques will be refined as NMFS adds information and researches critical uncertainties, such as the effectiveness of hatchery spawners in the wild. Section 9.5 describes a process for coordinated review of the scientific literature and selection of appropriate methodologies before the 5- and 8-year reviews.

NMFS recognizes that the lambda estimates express just one of several characteristics of a salmon population that must be examined when judging the health or risks it faces. Other characteristics are abundance, genetic diversity, life history diversity, and geographic distribution. NMFS intends to apply these principles to the listed ESUs in the basin through its recovery planning process, which will develop specific recovery goals and measures for the ESUs by the 2003 check-in. NMFS expects that the goals may provide a scientific foundation for refining the population-level performance measures. Other estimates of population productivity include recruits per spawner (R/S) and smolt-to-adult returns (SARs). R/S estimates require information on age structure and cannot be applied to as many populations as lambda. Both estimates convey similar information. SAR is a useful measure, but it covers only part of the life cycle, while information on the entire life cycle is necessary to gauge population status.

In the July 27, 2000, Draft Biological Opinion (NMFS 2000b), NMFS proposed two action levels for the 5- and 8-year reviews. A level of 1.1 was considered favorable enough to continue implementation without further review, and a level of 0.95 was considered unfavorable enough by year 8 to receive an automatic failure report. A lambda level of 1.1 or higher means a population will double in 8 years. A lambda value of 0.95 means a population will halve in 14 years. One commenter favored the simplicity and clarity of those thresholds. Others, however, pointed to the difficulty of measuring changes in lambda resulting from the RPA by year 8 and the near certainty that the long-term average would still be below 1.1 by then. That would eliminate any ability of the test to discriminate between success and failure. NMFS agreed with many comments. NMFS was also concerned that using a single absolute threshold would not reflect differences in current population growth rates or in the growth rates needed to meet survival and recovery indicator metrics. For those reasons, NMFS revised the 5- and 8-year tests as described below.

In 2005, updated population growth rates will reflect natural variations in survival and the effect of actions taken in the 1990s, including actions taken under prior biological opinions that are incorporated into the jeopardy analysis of the proposed action in this opinion. The key question to be addressed at the 5-year checkpoint will be whether the population growth rate has improved enough relative to the level estimated in this biological opinion to maintain a high likelihood of achieving the 2008 performance standards. This question will be answered with a four-part comparison of average values. The increase does not have to be statistically significant because NMFS recognizes the high variability of the estimates and the difficulty of establishing statistical significance in only 5 years. The ESUs will not be placed at higher risk due to this simple comparison, because the purpose of the test is to trigger additional conservation measures.

For the 5- and 8-year reviews, this RPA establishes three separate tests related to the annual population growth rate (e.g., lambda)[2] and a fourth test related to abundance.

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[2]In this discussion, lambda is used as shorthand for an estimate of the population growth rate. NMFS believes the best available information supports the use of lambda at this time. By referring to lambda, however, NMFS does not mean to exclude alternative measures that could be developed and applied in future analyses. As described above, the check-in process described in Section 9.5 includes a coordinated process for selection of appropriate methods based on scientific development before the 2005 evaluation and again before the 2008 evaluation.

- The first test assesses whether the annual population growth rate (e.g., lambda, or a future metric developed to replace it) is greater in 2005 and in 2008 than the base-period value of lambda today. This test will compare lambda on the date of this biological opinion (i.e., measured from 1980 to 2000)[3] with the value of lambda in 2005 (i.e., measured from 1980 to 2004) and again in 2008 (i.e., measured from 1980 to 2007). In each case, the test is passed if lambda has increased. If the newer value is lower, then additional review and actions will be triggered, as described in Section 9.5.

- The second test is whether, in 2005 and again in 2008, the annual population growth rate is greater than or equal to the projected growth rate based on improvements made and expected from actions taken in the 1995 biological opinion, reductions in harvest that occurred after the base period, and the survival standards in the Mid-Columbia Habitat Conservation Plan.[4] In essence, this test asks whether NMFS is actually seeing the positive results from these actions that have been incorporated into the analysis in this biological opinion. This test will compare the estimated current lambda (roughly 1993 to the present) to the actual measured lambdas in 2005 and again in 2008. If the actual lambda is greater, the test is passed. If it is smaller, then additional review will assess the significance of the time series used in this analysis compared to data from returns that benefitted from actions taken in 1995 and later. This could trigger additional actions, as described in Section 9.5.

- The third test will compare population growth rates in 2005 and 2008 against the rates needed to achieve the recovery metrics described in Section 1.3.1.2.2. The projected lambda will be based on the best available information about the effects actually being realized from hydro improvement and offsite mitigation measures included in this biological opinion and other changes being implemented in accordance with the Basinwide Recovery Strategy. The projections must meet or exceed the lambda necessary to achieve the 48-year recovery criteria, i.e., NMFS must be on track to meet these criteria. If not, additional review and, possibly, additional actions would be triggered, as described in Section 9.5.

[3]The dates defining the various periods are approximate. In almost all cases, 1980 used as a starting date refers to the 1980 brood year. Ending dates vary by species and are intended to mean the most recent year for which adult returns are available at the time of the analysis. Thus 1980 to 1999 may mean the 1980 brood year through 1999 adult returns for one ESU, but 1980 to 1998 for another. Actions taken under the research, monitoring, and evaluation section are expected to improve on the timeliness of adult return information. Likewise, in the second test referred to in this section, the starting date is approximate and may vary by ESU based on the most recent year for which adult returns are available and on the variation in that ESU. The more variable the ESU, the longer the period necessary to produce an estimate of sufficient precision. In general, the methodology described in McClure et al. 2000c, that is the basis of the estimates in this biological opinion, requires at least 11 years to develop an estimate.

[4]Changes in harvest are based on current restrictions. Changes in passage survival at the five Mid-Columbia PUD dams are based on commitments by the PUDs to specific survival objectives for fish passage survival. In the case of the Douglas and Chelan county PUDs, the commitment is expressed in the form of an HCP that accompanies their application for an incidental take permit under ESA Section 10. A draft EIS on these applications is being readied for public comment in December 2000. Grant County has a signed settlement agreement that establishes comparable juvenile survival objectives.

- A fourth test, or true safety net test, will include a simple comparison of stock size (abundance) against current levels. Specifically, the test will compare the annual adult returns of wild fish for each ESU and population against the 5-year geometric mean as of the date of this biological opinion. Two consecutive annual returns below this level will trigger a concern that a critical population threshold may have been crossed. If returns fall short, additional review will include the degree and significance of this failure relative to population status information from recovery planning and other scientific information available at the time of the 5- and 8-year evaluation and could lead to additional actions, as described in Section 9.5.

Table 9.2-1 provides the best estimates of base period, estimated current, and recovery lambda values that will be applied at years 5 and 8. Table 9.2-2 provides the estimates of current abundance that will be applied in years 5 and 8. These tables report estimated values for seven ESUs; an eighth ESU that also depends on this RPA to avoid jeopardy (Snake River sockeye) is not included because there are too few fish to apply this type of quantitative analysis. The other four ESUs are not included because NMFS concluded in Section 8 that factors other than the FCRPS contributed to their decline and now limit their potential for survival and recovery (i.e., they are not jeopardized by the FCRPS due to its relatively small impact).

As recovery plans are completed for these ESUs, the specific spawning aggregations and the target abundance levels will be refined. These conclusions assume that the RPA, as a major component of the Basinwide Recovery Strategy, will improve the estimated current population growth rates. If the expectations of this and prior biological opinions are not realized as expected, additional FCRPS actions, such as preparations for breaching (preconstruction, engineering and design, and development of a socioeconomic mitigation plan) and additional structural or operational measures to improve juvenile or adult passage survival, would be triggered. See Section 9.5.

9.2.2.2 Standards Related to Effectiveness of Hydro and Offsite Actions

The Basinwide Recovery Strategy identifies actions expected to reduce the adverse effects of the environmental baseline and hydro, habitat, hatcheries, and harvest actions enough to allow the listed species to survive and recover. That expectation depends on the effectiveness of the identified actions in benefitting listed fish. The effectiveness of the actions in each sector of activity will require evaluation. Evaluations must be tailored to specific activities, but effectiveness must ultimately result in understanding the change in survival of listed fish in that life stage, which affects the population-level performance. The research, monitoring, and evaluation called for by the Basinwide Recovery Strategy and this biological opinion are intended to address the assessment of effectiveness.

9.2.2.2.1 FCRPS Hydro Performance Standards

Hydro performance standards are quantitative and include a timeline of 10 years for attainment. Hydro standards are defined as the estimated juvenile and adult survival levels throughout the

Table 9.2-1. Median annual population growth rate (lambda) estimated from years beginning in 1980, through most recently available year (1994, 1996, 1997, 1998, or 1999, depending upon stock); the expected lambda given continuation of current survival rates; and the lambda needed to meet recovery objectives as described in Section 1.3. Information obtained from Tables 6.3.1 through 6.3.3, 6.3-6 through 6.3-8, and 6.3-11, as well as A-2 through A-6.

Spawning Aggregation	Base Period Lambda (1980 brood year through the most recent year for which adult returns are available)		Estimated Current Lambda (base period adjusted for 1995 Biological Opinion, more recent harvest restrictions and Mid-Columbia HCP)		Recovery Lambda (growth rate needed to meet recovery objective in 48 years or, absent a recovery objective, 1.0)	
	Low	High	Low	High	Low	High
Snake River Spring/Summer Chinook						
Bear Valley/Elk Creeks	1.02	1.03	1.06	1.09	1.05	1.05
Imnaha River	0.88	0.92	0.92	0.98	1.04	1.04
Johnson Creek	1.01	1.03	1.06	1.10	1.03	1.03
Marsh Creek	0.99	1.00	1.03	1.06	1.07	1.07
Minam River	0.93	1.02	0.98	1.09	1.05	1.05
Poverty Flats	0.99	1.02	1.04	1.09	1.03	1.03
Sulphur Creek	1.04	1.05	1.09	1.12	1.07	1.07
Snake River Fall Chinook						
Aggregate	0.87	0.92	0.93	1.03	1.05	1.05
Upper Columbia River Spring Chinook						
Wenatchee River	0.80	0.92	0.81	0.96	1.06	1.10
Snake River Steelhead						
A-run Aggregate	0.74	0.85	0.78	0.92	>1.00	>1.00
B-run Aggregate	0.74	0.84	0.79	0.89	>1.00	>1.00
Upper Columbia River Steelhead						
Methow River	0.81	0.97	0.86	1.06	1.08	1.08
Mid-Columbia River Steelhead						
Deschutes River Sum	0.77	0.84	0.78	0.85	>1.00	>1.00
Warm Springs NFH	0.91	0.91	0.92	0.92	>1.00	>1.00
Umatilla River Sum	0.90	0.90	0.92	0.93	>1.00	>1.00
Yakima River Sum	1.01	1.04	1.00	1.04	>1.00	>1.00
Columbia River Chum Salmon						
Grays River west fork	1.23	1.23	1.23	1.23	>1.00	>1.00
Grays R mouth to head	0.96	0.96	0.96	0.96	>1.00	>1.00
Hardy Creek	1.05	1.05	1.05	1.05	>1.00	>1.00
Crazy Johnson Creek	1.16	1.16	1.16	1.16	>1.00	>1.00
Hamilton Creek	0.92	0.92	0.92	0.92	>1.00	>1.00
Hamilton Springs	1.11	1.11	1.11	1.11	>1.00	>1.00

Table 9.2-2. Estimates of current abundance by ESU and population for the most recent 5 years for which return data are available. Values in the wild only column will be applied in the 5- and 8-year check-ins.

Spawning Aggregation	5-yr. Geometric Mean Incl. Hatchery Fish	5-yr Geometric Mean Wild Only	Last Year of Mean	Data Type
Snake River Spring/Summer Chinook	8,736	3,469	1999	Dam Count
Bear Valley/Elk Creeks	90	90	1999	Run reconstruction
Imnaha River	215	106	1999	Run reconstruction
Johnson Creek	69	69	1999	Run reconstruction
Marsh Creek	13	13	1999	Run reconstruction
Minam River	113	66	1999	Run reconstruction
Poverty Flats	190	178	1999	Run reconstruction
Sulphur Creek	15	15	1999	Run reconstruction
Snake River Fall Chinook				
Aggregate	566	394	1996	Run reconstruction
Upper Columbia River Spring Chinook				
Entiat River	39	26	1998	Run reconstruction
Methow River	132*	123*	1998	Run reconstruction
Wenatchee River	164	144	1998	Run reconstruction
Snake River Steelhead	71,105	8,683	1998	Dam count
A-run Aggregate	56,210	7,885	1997	Dam count
B-run Aggregate	12,274	1,248	1997	Dam count
Upper Columbia River Steelhead	2,127	703	1996	Dam count
Methow River				
Mid-Columbia River				
Deschutes River Sum	10,824	1,301	1996	Total live count
Warm Springs NFH Sum	164	not avail.	1995	Weir count
Umatilla River Sum	1,811	1,239	1996	Total live count
Yakima River Sum	979	933	1997	Dam count
Columbia River Chum				
Grays River west	33	33	1998	Peak counts
Grays River mouth to head	106	106	1998	Peak counts
Hardy Creek	253	253	1998	Peak counts
Crazy Johnson Creek	168	168	1999	Peak counts
Hamilton Creek	14	14	1998	Peak counts
Hamilton Springs	90	90	1999	Peak counts

*The Methow River spring chinook geometric mean estimate includes wild fish taken as hatchery brood stock for the natural stock supplementation program (1996 to 1998).

FCRPS that are expected to directly or indirectly result from the best or most extensive actions that are biologically feasible and within the authority of the Action Agencies. The hydro standards described in Table 9.2-3 involve uncertainty and annual variation. Assumptions about future survival rates are inherent in any projection of the likelihood of survival and recovery (i.e., a jeopardy analysis). NMFS believes, therefore, that the assumptions on which the analysis is based should be explicit.

Table 9.2-3. FCRPS hydrosystem survival performance rates (%) for affected life stages.

ESU	Adult Survival Rate		Juvenile Survival Rate		
	FCRPS System	Per FCRPS Project[1]	FCRPS Inriver Only		FCRPS Combined[2] (Transport + Inriver + Differential Mortality of Transported Fish)
			System	Per Project[1]	
Chinook Salmon					
SR spring/summer	85.5	98.1	49.6	91.6	57.6
SR fall	74.0	96.3	14.3	78.4	12.7
UCR spring	92.2	98.1	66.4	90.3	66.4
UWR	N/A	N/A	N/A	N/A	N/A
LCR	98.1	98.1	90.7	90.7	90.7
Steelhead					
SR	80.3	97.3	51.6	92.1	50.8
UCR	89.3	97.3	67.7	90.7	67.7
MCR	89.3	97.3	67.7	90.7	67.7
UWR	N/A	N/A	N/A	N/A	N/A
LCR	97.3	97.3	90.8	90.8	90.8
CR chum salmon	N/A	N/A	N/A	N/A	N/A
SR sockeye salmon	88.7	98.5	N/A	N/A	N/A

Source: Adult standards taken from Table 9.7-2. Juvenile standards taken from Table 9.7-1.
[1] Per-project inriver survival rate calculated as the xth root of the system inriver survival rate (where x = number of FCRPS projects encountered). They are provided for illustrative purposes only. They are *NOT* intended to be interpreted as project-specific standards, or to be used in any way to support curtailment of survival improvement measures at an individual project.
[2] Values represent averages over the water years and D values in Table 9.7-1.

In 2005 and again in 2008, NMFS will compare the post-2000 average survival with the average survival estimates in this biological opinion and with the survival improvements expected from RPA measures implemented by 2005 (or 2008). The progress check might consist of a series of two-sample statistical tests on one-sided hypotheses about juvenile survival levels. The tests would take into account uncertainty in both the 1994-to-1999 and the more recent averages. A first test could check whether the post-2000 estimate of survival was significantly lower than the 1994-to-1999 average, plus RPA improvements. The second test could check whether post-2000 survival was significantly higher than the 1994-to-1999 average. The purposes are to determine whether implemented actions are having the expected effects and to determine whether there is steady progress toward full achievement of the standard by year 10.

Because of the annual variability noted above, particularly in relation to environmental and hydrologic conditions and the limited years in the forthcoming progress evaluation, it may also be necessary to account for conditions that differ between the base period and the assessed period. That is, if conditions during the two periods are dissimilar, factoring may be necessary to ensure that the evaluation truly assesses the progress of actions undertaken and that the results are not masked by ambient conditions (environmental or hydrologic).

9.2.2.2.2 FCRPS Offsite Mitigation Performance Standards

FCRPS offsite mitigation builds on the hydro survival improvements called for in the hydro portion of the RPA, together with ongoing survival improvements from other habitat, hatchery, and harvest measures described in the Basinwide Recovery Strategy. The goal for FCRPS offsite mitigation is to improve fish survival over the life cycle beyond this base to help meet the biological requirements of the ESUs. Implicit in the analysis is the expectation that the combination of planned hydropower, hatchery, habitat, and harvest actions will result in enough survival improvements to meet ESA standards for the listed runs in the Columbia River basin.

Table 9.2-4 presents the estimated additional life-cycle survival improvements needed (relative to the survival and recovery metrics presented in Section 1.3.1.2), after accounting for the hydro survival improvements described above, and for estimated effects of changes in harvest and in passage survival at the Mid-Columbia PUD dams. The figures in the table come from the summary of effects over the full life cycle, presented by ESU in Section 9.7.2. Only ESUs for which NMFS concluded jeopardy are included in this table. SR sockeye are not included, because no quantitative analysis was possible. Additional improvements are also expected from actions taken by other Federal agencies described in the Basinwide Recovery Strategy, but which cannot be quantitatively estimated at this time. These improvements will likely contribute to the needed survival change. Offsite mitigation is expected to make up the remainder.

NMFS has determined that the offsite measures described in this RPA, as enhanced and modified through the 1- and 5-year planning process, and together with the measures identified in the Basinwide Recovery Strategy, are sufficient to achieve the biological requirements of the listed ESUs and, thus, sufficient to avoid jeopardy and adverse modification of critical habitat. This determination is made with full consideration of the additional increments of improvement needed, as reported in Table 9.2-4. However, NMFS determination is ultimately qualitative, informed (to the extent possible) by this standardized quantitative analysis. Due to substantial uncertainties, NMFS' determination is not currently placing a great deal of weight on the

Table 9.2-4. Estimated percentage change (i.e., additional improvement in life-cycle survival) needed to achieve survival and recovery indicator criteria after implementing the hydro survival improvements in the RPA. (A value of 26, for example, indicates that the egg-to-adult survival rate, or any constituent life-stage survival rate, must be multiplied by a factor of 1.26 to meet the indicator criteria.)

Spawning Aggregation	Needed Survival Change	
	Low	High
Snake River Spring/Summer		
Bear Valley/Elk Creeks	0	0
Imnaha River	26	66
Johnson Creek	0	0
Marsh Creek	0	12
Minam River	0	28
Poverty Flats	0	0
Sulphur Creek	0	5
Snake River Fall Chinook		
Aggregate	0	44
Upper Columbia River Spring		
Wenatchee R.	51	178
Snake River Steelhead		
A-run Aggregate	44	214
B-run Aggregate	92	333
Upper Columbia River Steelhead		
Methow R.	0	110
Mid-Columbia River Steelhead		
Deschutes R Sum	102	226
Warm Springs NFH Sum	36	36
Umatilla R Sum	27	31
Yakima R Sum	0	0
Columbia River Chum Salmon		
Grays R. west fork	0	0
Grays R. mouth to head	18	18
Hardy Creek	0	0
Crazy Johnson Creek	0	0
Hamilton Creek	36	36
Hamilton Springs	0	0

Notes: Low and high estimates are based on a range of assumptions, as described in the text.
The values presented in this table are intended to provide perspective and enable NMFS to make a qualitative judgment regarding the potential to improve the productivity of listed ESUs enough to avoid jeopardy. As discussed in the text accompanying this table, the effects of this uncertainty are particularly significant for SR steelhead and UCR chinook and steelhead.

quantitative analysis that produced these estimates. These uncertainties are thoroughly described in Sections 6 and 9 of this biological opinion. Of particular importance in considering the values in this table is the uncertainty related to the effects of hatchery fish. In general, the uncertainty between 20% and 80% effectiveness of hatchery spawners in the wild is responsible for much of the range between the low and high values in the table. The other assumption contributing to this uncertainty is the level of improvement in hydro survival between the baseline analysis and the adjustment for the effects of NMFS' 1995 Biological Opinion that are not included in the baseline due to the timing of adult return information. In addition, the applicability of the hatchery effectiveness assumption is questionable in some cases. For SR steelhead, for instance, many of the populations within the ESU are in areas not affected by hatchery fish. For these populations, the adjustment in the productivity of wild fish based on these assumptions may not even apply. However, since the CRI analysis relies on dam count information, these assumptions are applied to the ESU as a whole and probably result in overestimating the amount of additional survival improvement needed to satisfy the survival and recovery metrics for some populations.

NMFS plans to refine the analysis by addressing critical uncertainties and, eventually, by quantitatively defining and apportioning the life-cycle improvement necessary in specific life stages or sectors, including the FCRPS. Part of the additional, unquantifiable survival improvements in the Basinwide Recovery Strategy are expected to result from ongoing and prospective Federal actions in land management, hatchery reform, and estuarine restoration. FCRPS Action Agencies are responsible for the balance of the improvements necessary to ensure an adequate likelihood of survival and recovery to satisfy ESA Section 7 obligations for the listed stocks.

9.2.3 Physical Performance Standards

Physical performance standards supplement and sometimes serve as surrogates for biological performance standards. In the case of hydro actions, for example, some physical targets or goals are directed at measures such as mainstem flow objectives and water quality that are intended to guide water management decisions. These are described with the individual hydro actions in Section 9.6.1.

In the case of tributary habitat, physical standards might include instream flows; the amount and timing of sediment inputs to streams; riparian conditions that determine water quality, bank integrity, wood input and maintenance of channel complexity; and habitat access.

The Federal Action Agencies, working with CRI and EDT analysts, have established preliminary hypotheses linking habitat strategies and measures to key habitat attributes. The next steps will be as follows:

- Establish an initial set of performance standards and measures—ecological and management indicators—expressed as desired habitat trends.

- Implement pilot studies designed to test and confirm key assumptions that relate habitat improvements to life-stage survival improvements for listed fish species.

The studies needed to assess the specific ecological and management targets will be integrated into tier 3 of the research, monitoring, and evaluation program described in Section 9.6.5. The studies and the objectives may be refined in the first few years through targeted research, subbasin assessments, and finer-scale analysis. Subbasin assessments will use available tools for evaluating habitat quality and quantity and salmon productivity, including EDT, the Salmon Watershed Enhancement Model, and the CRI analysis. The initial 5-year plan (due on March 31, 2001) must include tests of intermediate-stage (egg-to-parr, parr-to-smolt) survival in selected places to check the effectiveness of habitat actions. The tests must be designed to support assessments at the 5- and 8-year checkpoints described in Section 9.5. They will enable policymakers to evaluate and refine hypotheses, adjust habitat measures, and reach further decisions on the contribution to recovery of habitat protection and restoration. They are high-priority projects for early implementation in fiscal year 2001.

Hatchery performance standards will be incorporated into the hatchery and genetic management plans (HGMPs). Standards will be developed in the following areas and measured over time for results:

- Genetic introgression: Local, within-ESU, broodstock is used in all propagation programs within critical habitat, unless associated with an isolated program. Hatchery broodstocks used in supplementation programs represent the genetic and life-history characteristics of the natural population(s) they are intended to supplement. Non-isolated hatchery programs regularly infuse natural-origin fish into the broodstock, as described in an approved HGMP.

- Hatchery-origin fish straying: For naturally spawning populations in critical habitats, non-ESU hatchery-origin fish do not exceed 5 percent; ESU hatchery-origin fish do not exceed 5 to 30%, unless specified in an HGMP for a conservation propagation program.

- Marking: Hatchery populations are properly marked so as not to mask the status of the natural-origin populations or the capacity and proper functioning of critical habitat.

- Viable and critical population thresholds: Hatchery operations do not appreciably slow a listed population from attaining its viable population abundance. Hatchery operations do not reduce listed populations that are at, or below, critical population abundance.

- Harvest effects: Federal hatchery mitigation fish produced for harvest do not cause subsequent overharvest of listed stocks such that their recovery is appreciably slowed. Harvesting reforms are implemented to maintain and enhance harvest of mitigation fish in consideration of the constrained productivity of listed stocks caused by the FCRPS and other development.

- Hatchery planning: Hatchery goals and objectives, operational protocols, monitoring and evaluation, anticipated effects, and relationship to other critical management and planning processes are fully described in approved HGMPs.

- Research: Scientific knowledge is increasing on the effects of hatchery supplementation and captive broodstock programs on the survival and recovery of natural-origin populations. The quality and survival of hatchery supplementation fish are increasing.

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9.3 SUMMARY OF OFFSITE MITIGATION PROGRAM

Offsite mitigation is used in this biological opinion to mean actions in the areas of habitat, hatcheries, and harvest that are expected to provide biological benefits to the listed stocks. In combination with efforts to reduce hydro mortality, improvements expected from other ongoing Federal actions, and the cumulative effects of state or private activities that are reasonably certain to occur, these actions should be sufficient to allow the FCRPS and BOR operations to meet the jeopardy standard. Offsite enhancement includes only measures that are within the current authorities of the Action Agencies.

Each of the Action Agencies currently has some authority to implement programs to benefit listed stocks that are outside of the scope of hydrosystem operations. BPA has authority pursuant to the Northwest Power Act to protect, mitigate, and enhance fish and wildlife affected by the construction and operation of the FCRPS. BPA implements this authority and fulfills its responsibility through the NWPPC's fish and wildlife program. Measures implemented under the program include actions in the areas of habitat, hatcheries, and, to a more limited extent, harvest. The Corps has existing authorities that provide opportunities for some hatchery and habitat improvements pursuant to the Lower Snake River Compensation Plan, the Columbia River Fish Mitigation Program, and other continuing authorities. The Corps is currently seeking authority to carry out habitat improvement activities in the estuary. BOR is authorized, pursuant to the Reclamation Act of 1902, to provide technical assistance to others to address instream habitat improvements; however, BOR only has authority to fund water acquisition and to supply technical assistance for screening and passage improvements. Additional BOR participation in implementing tributary habitat improvement actions is contingent upon acquiring such authority from Congress or acquiring funds to implement the actions from sources other than BOR appropriations.

The Action Agencies will exercise these authorities to implement offsite mitigation actions outside the operation of the hydrosystem. This will be an important contribution toward achieving the standards for offsite mitigation.

Offsite mitigation measures are identified in the RPA in the areas of habitat (Section 9.6.2), harvest (Section 9.6.3), and hatcheries (Section 9.6.4). These measures are intended to complement, not substitute, for actions on Federal lands by Federal land management agencies or actions in the hatchery and harvest arena by other Federal agencies consistent with the Basinwide Recovery Strategy and related biological opinions. The measures identified as offsite mitigation in this biological opinion are targeted at providing biological benefits for the listed ESUs that are the subject of this consultation and will be credited toward achievement of the offsite mitigation performance standards.

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9.4 DEVELOPMENT AND IMPLEMENTATION OF 1- AND 5-YEAR PLANS

This section outlines an annual process for developing and implementing 1- and 5-year plans to achieve both FCRPS hydro performance and offsite mitigation performance standards. The plans will cover all operations, configuration, research, monitoring, and evaluation actions for the FCRPS. The plans will also describe habitat, hatchery, and harvest actions to be funded or otherwise carried out by the Action Agencies as offsite mitigation. The advance planning process outlined in this section is critical to achieving the FCRPS hydro and offsite performance standards within the time-frame of this biological opinion.

9.4.1 Development and Implementation of the 1- and 5-year Plans

The following action describes in more detail the expectations for the development and implementation of the 1- and 5-year plans.

Action 1: The Action Agencies, coordinating with NMFS and USFWS, shall annually develop 1- and 5-year plans to implement specific measures in hydro, habitat, hatcheries, harvest, research, monitoring, and evaluation needed to meet and evaluate the performance standards contained in this biological opinion.

The annual planning process is expected to provide the following key benefits:

- A comprehensive plan that identifies progress made and actions needed to achieve FCRPS hydro and offsite mitigation performance standards

- Integration of all FCRPS operations, configuration, research, monitoring, and evaluation actions

- Specific actions to be carried out as offsite mitigation for the effects of the FCRPS and how they will be credited

- Priorities to guide regional planning and in-season actions

- A comprehensive plan to support funding requests

To the extent possible, the plans will be coordinated through established local, regional, and Federal processes. USFWS is referenced in this process to ensure coordination on actions that may affect USFWS hatchery and resident species responsibilities. The responsibility for meeting the performance standards in this biological opinion rests, however, with the Action Agencies. NMFS has the responsibility for determining the adequacy of the 1- and 5-year plans. Regional implementation forums that include participation by entities other than the Action Agencies are described in the following sections. The intent of these processes is to ensure the broadest possible technical and policy input and information from the region's Indian Tribes and state fish and wildlife managers. While consensus on regional issues is a desired outcome of these processes, failure to reach consensus after full and measured discussion, or lack of participation by the other parties, is not intended to indicate a failure to comply with any of the RPAs.

The planning and implementation process described in this section has the following elements:

- The Action Agencies, with assistance from NMFS and USFWS, will develop a 5-year implementation plan that includes FCRPS and offsite mitigation measures. The hydro portion of the initial 5-year plan will include those specific measures in this RPA for hydrosystem operations, configuration, research, monitoring, and evaluation. The offsite mitigation portion will include specific additional measures in habitat, harvest, and hatcheries from this RPA and the Basinwide Recovery Strategy including research, monitoring, and evaluation. These additional measures are the responsibility of the Action Agencies to fund or carry out, and they include measures that would benefit from involvement and/or contribution of the Action Agencies.

- The 5-year plan will focus on the middle to long term, describing the Action Agencies' programs and how they are intended to meet FCRPS and offsite mitigation performance standards. The plan will detail, as specifically as possible, the measures in those programs, together with schedules and budgets. As a long-term planning tool, the 5-year plan will focus on out-year costs of the measures to ensure budgets and budget requests are adequate to carry out planned activities.

- The initial 5-year plan should be completed by March 31, 2001, and annually thereafter by September 1 (or as mutually agreed upon by the Action Agencies, NMFS, and USFWS).

- NMFS encourages coordination with the Columbia River basin's Indian Tribes and state fish and wildlife managers in development of the 1- and 5-year plans in order to gain the full benefit of cooperative adaptive management with the region's scientists.

- The 5-year plan will guide the Action Agencies, NMFS, and USFWS as they participate in various regional planning processes in which they are collectively or individually involved. Examples are the NWPPC's Fish and Wildlife Program prioritization process, Action Agency budget requests, and production discussions within *U.S. v. Oregon* (which do not directly involve the Action Agencies).

- The Action Agencies, with assistance from NMFS and USFWS, will complete a 1-year plan. The 1-year plan will provide the additional project-specific detail needed to implement the first year of the more general 5-year plan. Both new and ongoing activities should be identified. The first 1-year plan will be completed by September 1, 2001, and annually thereafter on a date that is mutually agreed upon by the Action Agencies, NMFS, and USFWS. The 1-year plan will incorporate, to the greatest extent possible, the measures developed in regional planning and prioritization processes, but the Federal agencies will not necessarily be limited to only measures approved through those processes. Where differences exist, the plan will explain the differences.

- NMFS will review the 1-year plan for consistency with the biological opinion and issue a finding as to whether the plan is adequate.

- The 1- and 5-year plans will be implemented through a variety of processes. The FCRPS hydro action portion of the plans will be implemented through the existing NMFS Regional Implementation Forum process and, where appropriate, the BPA funding process. The offsite mitigation portions of the plans will be implemented through the BPA funding process, Action Agency budget requests, and other processes as appropriate.

- The Action Agencies are expected to participate in good faith in the regional forums and processes in order to seek agreement on the adaptive management steps necessary to avoid jeopardy. They may convene any additional meetings to gain input from affected parties. However, the Regional Implementation Forum will be the principal decision-making forum for issues related to this biological opinion.

- The Action Agencies may wish to develop one comprehensive plan that consolidates other program activities (e.g., the Columbia Basin Fish and Wildlife Program) with those being done for ESA purposes. If the plans are consolidated, the Action Agencies will specifically identify those measures in this RPA that are the responsibility of the Action Agencies to fund or carry out and those offsite mitigation actions they propose to implement to meet the performance standards.

The 1- and 5-year implementation plans and their priorities should consider the following factors:

- The current status of the various ESUs

- Recent data or results of research, monitoring, and evaluation actions

- Feasibility and timing of implementing each measure

- Probability of success for each measure. The 5-year plan should explain how all the actions together contribute to meeting the performance standards.

- State and Tribal plans and input from state and Tribal comanagers

9.4.2 Process for Developing and Implementing Key Elements of the 1- and 5-Year Plans

The following sections define the process of developing and implementing key elements of the 1- and 5-year implementation plans. The major elements of the plan and of the planning process (described in the following subsections) are as follows:

1. Hydrosystem Plan
2. Operations — Water Management Plan
3. Configuration — Capital Investment Plan
4. Water Quality Improvement Plan
5. Operations and Maintenance Plan
6. Offsite Mitigation — Habitat Plan
7. Offsite Mitigation — Hatcheries and Harvest Plans
8. Research, Monitoring, and Evaluation Plan
9. Tribal Coordination on Hydro and Offsite Mitigation Actions
10. Recovery Planning
11. Unanticipated Actions
12. Approval of Plans
13. Annual Progress Reports

9.4.2.1 Hydrosystem Plan

Action 2: The Action Agencies shall coordinate development and implementation of the hydro portion of the 1- and 5-year implementation plans through the Regional Forum, chaired by NMFS.

The hydro portion of the 1-year plan will describe specific actions to be taken in the coming year to achieve the hydrosystem performance standards. It will incorporate and integrate specific measures developed in the water management, capital investment, and water quality improvement plans, described below. Section 9.6.1 of this biological opinion describes objectives and a number of operational and structural measures that will serve as the basis for the initial operations and configuration actions in the hydro portion of the 1- and 5-year plans. Sections 9.6.1 and 9.6.5 also include research, monitoring, evaluation, and planning measures that, when completed, will guide future implementation decisions. The RPA anticipates that these research and planning actions, together with future decisions made through the 1- and 5-year planning process, will amend the RPA measures. NMFS will explicitly define and approve all such amendments in its written findings.

Development and implementation of the hydro portion of the 1- and 5-year plans will be coordinated through the NMFS Regional Implementation Forum, established in the 1995 Biological Opinion and led by the Implementation Team. The goal of this forum is to ensure the broadest possible technical and policy input in planning, funding, and implementation decisions regarding the operation and configuration of the FCRPS. Consensus should be sought on issues affecting the region to foster cooperation in the adaptive management process and longevity of decisions. However, nothing in the Regional Implementation Forum process is intended to dilute or remove the authority of any agency. Membership on the Implementation Team is open to senior program and policy level personnel from the states, Tribes, and Federal agencies. The teams and subgroups operating under the Implementation Team's guidance are open to Federal, state, and Tribal representatives with technical expertise in hydroelectric operations and/or the effects of hydroelectric operations on fish, particularly on migrating juvenile and adult salmonids and native resident species, and water quality. In particular, the Action Agencies and NMFS have invited and encouraged participation by the four northwest states and Alaska, 13 Columbia River Tribes, CRITFC, USFWS, EPA, NWPPC, the Mid-Columbia PUDs, and Idaho Power Company. All meetings of the NMFS Regional Forum teams are professionally facilitated and are open to the public. Meeting minutes are distributed to members and the public and are available for review at the NMFS Hydro Division in Portland, or on NMFS' Northwest Region home page at www.nwr.noaa.gov/1hydrop/hydroweb/default.html.

The Implementation Team will meet monthly, or otherwise as needed, to oversee the activities and resolve disputes arising through the Technical Management Team, the System Configuration Team, and the Water Quality Team. The Implementation Team and each of the technical teams will regularly review and approve guidelines or procedural rules. Draft guidelines now in place will serve as default rules for the Implementation Team until it can adopt different rules. Copies of the guidelines are also available on the website or may be obtained from the NMFS Hydro Division in Portland, Oregon.

Given the development of the annual planning process, it may be appropriate for the Implementation Team and all technical teams operating under its guidance to review their guidelines, rules of procedure, and meeting structures to ensure that the teams are prepared to address the annual planning process. Further, it is anticipated that new subgroups may be needed to address resident fish and data management issues. Such subgroups are not described in this section, but may be developed through the Regional Forum and the annual planning process.

9.4.2.2 Water Management Plan

Action 3: The Action Agencies, coordinating through the Technical Management Team, shall develop and implement a 1- and 5-year water management plan and in-season action plans for the operation of the FCRPS.

The 1- and 5-year water management plans will define how the FCRPS will be operated to achieve the performance standards. It will also include a prioritized list of research, monitoring, and evaluation needs associated with implementing the annual water management plans. As an advance planning document, the 5-year water management plan will provide clear objectives, evaluation points, decision criteria, and priorities for the objectives. Given these priorities, the plan will address any significant changes from prior year operating plans. It will specify any criteria being used to begin or end a particular planned operation. The plan should specifically address exceptions for emergencies declared to ensure the reliability of power supply and transmission service. In addition, the annual plan will include consideration of research, monitoring, and evaluation activities that require special operations. The 5-year water management plan must be incorporated into the 1-year plan by September 1 of each year to ensure timely consideration for funding of associated research, monitoring, and evaluation. This is well before runoff projections are available for the coming year. For this reason, the water management plan will have to contain objectives, priorities, and decision criteria for various water conditions.

This timeline for the 1- and 5-year water management plans does not allow for consideration of specific water-year information. Therefore, the Action Agencies will coordinate through the Technical Management Team to prepare more detailed spring/summer and fall/winter action plans that address spring runoff, summer flow augmentation, fall spawning, and winter incubation seasons. The spring/summer plan will be initiated with the January 1 forecast and updated each month as the new forecast information becomes available. The fall/winter plan will be initiated in September using the best currently available long-range hydrologic and oceanographic information and updated as better information becomes available.

Given the emphasis on advance planning, the Technical Management Team may have to meet only biweekly or monthly during the spring and summer migration and fall spawning seasons to advise the Action Agencies on the status of salmonid migrations and spawning activity, and to review dam and reservoir operations for optimal conditions affecting juvenile and adult anadromous salmonids. The water management plan and the more detailed spring/summer and fall/winter plans, together with the provisions of Section 9.6.1.2, will guide the Technical Management Team in-season management process.

NMFS received comments on a number of process issues related to the Technical Management Team, including frequency of meetings, retention of a meaningful role for the state and Tribal participants, and the need for more explicit provisions to deal with power supply and transmission system emergencies such as occurred in the summer of 2000. In general, NMFS believes that refinement of the in-season management process should be carried out through the established Regional Forum rather than specified as part of this biological opinion (such as occurred with the Technical Management Team's development of the September 22, 2000, "Protocols for Emergency Operations in Response to Generation or Transmission Emergencies"). Specific changes that should be considered through that process include assessing the continuing need for weekly meetings once the more detailed in-season action plans contemplated by this action are done, the venue for such meetings (e.g., annual meetings in Idaho and Montana to discuss potential site-specific impacts at key points during the season), and the need for some level of involvement by regional executives to address power supply or transmission system emergencies of exceptional magnitude or duration.

9.4.2.3 Capital Investment Plan

Action 4: The Action Agencies, coordinating through the System Configuration Team, shall annually develop and implement a 1- and 5-year capital investment plan for the configuration of the FCRPS projects.

The capital investment plan will prescribe investment, research, monitoring, evaluation, and O&M actions to achieve the performance standards. As an advance planning tool, the capital investment plan will address specific objectives and priorities for improving fish passage and water quality. Given the objectives and priorities, the plan will define research, development, and implementation of FCRPS facility improvements to improve anadromous fish passage survival. To the extent that any actions require special system or project operations, the implementation dates and operations will be coordinated with the Technical Management Team and the development of the annual water management plan. O&M needs and budgets associated with the capital investment plan will also be developed.

The SCT will meet monthly or as needed to consider the results of scientific and engineering studies and to develop and recommend FCRPS fish facility improvements, including their priority, implementation schedule, and budget needs.

9.4.2.4 Water Quality Plan

Action 5: The Action Agencies, coordinating through the Water Quality Team, shall annually develop a 1- and 5-year water quality plan for operation and configuration measures at FCRPS projects.

Numerous actions throughout the RPA improve fish passage and survival through measures to improve water quality. The water quality improvement plan will describe the objectives, priorities, and decision criteria for these measures and the specific implementation plans. Given these objectives and priorities, the plan will recommend FCRPS facility and operational improvements related to water quality, gas and temperature monitoring needs, and related studies. In developing the water quality improvement plan, the Water Quality Team will integrate and coordinate its recommendations with the annual water management and the capital investment plans.

9.4.2.5 Operation and Maintenance Plan

Action 6: The Corps and BPA, through the annual planning process, shall develop and implement 1- and 5-year operations and maintenance (O&M) plans and budgets that enhance the capability to operate and maintain fish facilities at FCRPS projects for listed salmonid stocks.

In recent years the Corps' O&M program budget for operations and maintenance of fish passage facilities at FCRPS projects has remained static and has not met increased needs. As a result, there is a growing backlog of needed maintenance actions. Enhanced preventive maintenance programs are needed to avoid costly and untimely repairs and to improve facility reliability. New fish passage facilities being installed will create new O&M needs. Other operational needs, such as increased juvenile fish barging, also raise annual O&M budget requirements. To address these needs, the O&M annual budget should reflect the 1- and 5-year plans to be developed by the Corps in coordination with FPOM and approved by the System Configuration Team. The 1- and 5-year plans will be based on the following:

- Development of a fish facilities preventive maintenance program
- Current requirements for updating aging facilities
- Requirements of new facilities scheduled to come on line each year
- Debris-handling needs and techniques
- Current operations and any anticipated changes.

The Corps' resource capability to undertake and implement O&M actions should also be considered.

9.4.2.6 Offsite Mitigation—Habitat Plan

Action 7: The Action Agencies, with assistance from NMFS and USFWS, shall annually develop 1- and 5-year plans for habitat measures that provide offsite mitigation.

The habitat portion of the initial 5-year plan will include programs and measures from the Basinwide Recovery Strategy that are the responsibility of the Action Agencies to fund or carry out. The plan will include schedules and costs associated with the habitat programs. The 5-year plan will also include an analysis of how the habitat measures will meet the performance standards established in this biological opinion. The Basinwide Recovery Strategy calls for the creation of a Federal Habitat Team. The Action Agencies should employ this mechanism to integrate offsite mitigation outlined in the initial 5-year plan with other federal habitat programs. Using the 5-year plan as guidance, and in consultation with the Federal Habitat Team, NMFS, USFWS and the Action Agencies will participate in regional planning and prioritization processes, but the Federal agencies will not necessarily be limited to only those measures approved through those processes.

NMFS expects to rely heavily on NWPPC's subbasin planning process for the identification and development of offsite habitat mitigation opportunities. This process capitalizes on the technical expertise within the fish and wildlife agencies and Tribes and takes into account their management recommendations, includes technical review by the NWPPC's Independent Scientific Review Panel, and involves local communities and the public. The 1-year plan will incorporate, to the greatest extent possible, the measures developed in the regional planning and prioritization processes. The plan will explain any differences between measures contained in the plan and measures developed in other regional processes.

9.4.2.7 Offsite Mitigation—Hatcheries and Harvest Plans

Action 8: The Action Agencies, with assistance from NMFS and USFWS, shall annually develop 1- and 5-year plans for hatchery and harvest measures that provide offsite mitigation.

The harvest and hatchery portion of the initial 5-year plan will include those specific measures and programs from the Basinwide Recovery Strategy that are the responsibility of the Action Agencies to fund or carry out. The plan will include schedules and costs associated with the harvest and hatchery programs. The 5-year plan will include an analysis of how the harvest and hatchery measures will meet the performance standards established in this biological opinion. Using the 5-year plan as guidance, NMFS, USFWS, and the Action Agencies will participate in regional planning and prioritization processes. Those processes include, but are not limited to NWPPC's prioritization process, *U.S. v. Oregon* production discussions (NMFS and USFWS; not the Action Agencies), and budget requests.

The 1-year plan will incorporate, to the greatest extent possible, the measures developed in regional planning and prioritization processes, but will not necessarily be limited to actions approved through those processes. The plan will be consistent with any provisions established by *U.S. v. Oregon*. The plan will explain any differences between measures it contains and measures developed in other regional processes.

9.4.2.8 Research, Monitoring, and Evaluation Plan

Action 9: The Action Agencies, with assistance from NMFS and USFWS, shall annually develop 1- and 5- year plans for research, monitoring, and evaluation to further develop and to determine the effectiveness of the suite of actions in this RPA.

Research, monitoring, and evaluation will provide data for resolving a wide range of uncertainties, including determining population status, establishing causal relationships between habitat (or other) attributes and population response, and assessing the effectiveness of management actions. Progress on resolving these uncertainties will be a primary consideration in the 1- and 5-year planning process as well as in the 5- and 8-year check-ins. Monitoring and evaluation may lead to revisions in measures the Action Agencies undertake to meet performance standards, or in the performance standards themselves, to ensure that the overall program is sufficient to avoid jeopardy to listed ESUs. Such programs are, therefore, critical to the successful implementation of this RPA.

Section 9.6.5 describes a framework for a comprehensive research, monitoring, and evaluation program. Many specific actions are already identified in that section, but the plan is not limited to those listed. NMFS expects the Action Agencies to start work on the listed actions concurrent with the development of the 1- and 5-year plans.

9.4.2.9 Tribal Coordination on Hydro and Offsite Mitigation Actions

The Action Agencies and NMFS encourage participation by the Tribes and Tribal organizations in all of the Technical Management Team, System Configuration Team, Water Quality Team, and Implementation Team processes, and in regional planning activities such as the CBFWA/NWPPC process where much of the planning for offsite mitigation activities will occur. Such participation will provide abundant opportunities at the technical level to collect, synthesize, and exchange information and to seek consensus on implementing the hydro and offsite mitigation actions identified in the biological opinion. Discussions at the policy level are also important and may occur through direct communications with Tribes or through policy level forums such as the Columbia River Basin Forum.

The Action Agencies, in keeping with their Federal trust responsibilities, will coordinate with and seek the input of appropriate Tribes during their development of the 1- and 5-year plans. The 5-year plan will be subject to NWPPC's public process, providing additional opportunities for input from Tribes, state fish and wildlife managers, and the public before the 1-year plan is drafted.

9.4.2.10 Recovery Planning

Action 10: The Action Agencies shall work with NMFS and others to promptly incorporate the results of recovery planning into annual Fish and Wildlife Program implementation funding, including support for incorporation of the results into the NWPPC's Fish and Wildlife Program.

As portions of recovery plans become final, NMFS and the other Action Agencies will incorporate applicable elements into the progress reviews and the 1- and 5- year plans described in this RPA. If the incorporation of such recovery plan elements could entail major changes in analyses or actions, the Action Agencies may reinitiate consultation with NMFS.

NWPPC recently amended its Fish and Wildlife Program to be implemented through a 3-year rolling provincial review. The NWPPC's intent is to identify and fund all actions in a province for 3-year periods. Provincial reviews will incorporate the findings of subbasin assessments and subbasin plans when they are complete. Ideally, NMFS' recovery plans would be available to provide quantitative biological goals and spatial and action priorities to guide provincial reviews and subbasin plans toward achieving recovery. However, NMFS' recovery plans will lag behind the first round of provincial reviews. To address this timing problem, NMFS commits to working on provincial reviews and subbasin plans to optimize the Fish and Wildlife Program's ability to meet ESA needs before recovery planning. Responding to recovery plan goals and actions as they emerge may require some midcourse adjustments in areas with previously completed provincial reviews and subbasin plans. When BPA receives its annual fish and wildlife program recommendations from NWPPC, therefore, it should consider consistency with the latest ESA findings and priorities both in new, as well as in completed, provincial reviews in preparing its 1-year funding plans.

9.4.2.11 Unanticipated Actions

***Action 11*:** By September 30, 2001, the Action Agencies shall develop procedures for carrying out actions that could not be anticipated in the planning process, but that are necessary or prudent to achieve the performance standards.

Scientifically sound projects or operational measures of a limited duration and scale may arise that, for a variety of reasons, were not considered during the normal planning processes. Delaying their implementation to conform to those processes might be impractical or inconsistent with information needs associated with the midpoint evaluation process. To address this concern, the Action Agencies will, in collaboration with NMFS and USFWS, develop an expedited process for implementing new or unplanned activities that might result from new findings, that constitute emergency actions, or that present an unforeseen opportunity. Until the Action Agencies develop an explicit process, they will proceed with any necessary and prudent unanticipated actions after adequate informal coordination with and approval by NMFS.

Because the first 1-year plan under this RPA will not be completed until September 2001, a number of early-implementation, high-priority actions may be added to existing plans for fiscal year 2001. This will be particularly important for research, monitoring, and evaluation needed to assess performance standards.

9.4.2.12 Approval of Plans

Action 12: The Action Agencies shall coordinate with NMFS and USFWS in the review of the 1- and 5-year plans to facilitate timely review and approval as part of the annual decision process.

The responsibility for meeting the performance standards in the biological opinion rests with the Action Agencies, based on their implementation of the 1- and 5-year plans. NMFS and USFWS will participate in the development of the 1- and 5-year plans, considering consistency with their biological opinions; adequacy of the level of effort being undertaken in habitat, harvest, hatcheries, and hydro; priority of actions; and progress toward achieving performance standards or objectives. Within 45 days of receipt of each 1-year plan, NMFS and USFWS will issue a findings letter to the Action Agencies regarding the adequacy of the plan. The letter will address the consistency of the proposed annual plan with the reasonable and prudent alternative of the biological opinion and, if appropriate, recommend needed changes. If NMFS finds the plan to be inadequate, the Action Agencies may proceed with those elements of the plan not identified by NMFS or USFWS as at issue, while discussions continue regarding how to align the plan with the biological opinion.

The plans will be carried forward into the appropriate Federal or regional planning process. The Action Agencies will expedite implementation unless there are technical or feasibility impediments that cannot be reconciled, or appropriations are not forthcoming from Congress.

9.4.2.13 Annual Progress Reports

Action 13: The Action Agencies shall issue annual reports to NMFS and USFWS on progress toward achieving the performance standards set out in this biological opinion, including comprehensive cumulative reviews in years 3, 5, and 8.

As part of the preparation for the annual planning process described in this section, the Action Agencies will prepare progress reports for NMFS' review. These annual progress reports will document the Action Agencies' findings regarding each of the following:

- Compliance by the Action Agencies with the measures and schedules described in this biological opinion and in 1- and 5-year plans, including a thorough discussion of any impediments to full implementation (e.g., lack of necessary authority or appropriation)

- Progress toward meeting the interim and long-term performance standards for hydrosystem improvements and offsite mitigation established pursuant to this biological opinion and any failure to meet such standards

- Projected progress toward full achievement of performance standards through future actions, or through future benefits of ongoing actions, and the risks that such progress will not be achieved

- Lessons learned, new information, and related adjustments made in actions, standards, or monitoring and evaluation, specifically including the following:

    - Results from pilot studies that may confirm or rebut key assumptions regarding the ability of habitat actions identified in this biological opinion and in the Basinwide Recovery Strategy, as necessary to improve life stage survivals of listed fish species

  - Progress towards resolving critical uncertainties including the effectiveness of naturally spawning hatchery fish, delayed mortality associated with transport, and delayed mortality associated with in-river migration

- Current adult returns and population trends

NMFS, working through the Regional Forum and the Independent Scientific Advisory Board, will obtain independent scientific review of its 5-year and 8-year evaluation reports. The progress reports will better enable NMFS and the Action Agencies to assess progress and the possible need for additional measures.

To the extent the actions or programs are not being implemented as described in the RPA, or fall short of meeting performance measures such as needed improvements in hydrosystem survival, the Action Agencies will propose additional measures to address such shortcomings in their annual updates to the 1- and 5-year plans.

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9.5 DESCRIPTION OF MID-POINT EVALUATION PROCESS

9.5.1 Overview

Inclusion of a process to ensure that the required measures are implemented and effective is a critical feature of this RPA. The Action Agencies must be certain that the projects covered by this biological opinion continue to avoid jeopardy and adverse modification of critical habitat for the listed species. At the same time, the Action Agencies must monitor the status of the listed species to ensure that their condition does not worsen unexpectedly despite the actions of this RPA and other conservation measures. These are the purposes of the mid-point evaluation process.

This process overlays the 1- and 5-year planning process discussed in Section 9.4. It incorporates the annual progress reports required for development of 1- and 5-year plans. In years 3, 5, and 8, the agencies perform a more detailed assessment of the RPA's implementation and effectiveness. In years 5 and 8, NMFS will also reevaluate application of the jeopardy/adverse modification standard based on current information, simultaneously reassessing the current status of the listed stocks. NMFS will issue a report at each of these check-in years, documenting whether the RPA is on track or fails to meet expectations. The year 5 and 8 reports, along with the progress reports submitted by the Action Agencies, will be submitted for scientific peer review. Figure 9.5-1 illustrates the timeline for this review process. Figure 9.5-2 provides an overview of the decision structure for the mid-point evaluation process.

NMFS' reports will determine whether, on balance, the Action Agencies' implementation of the RPA is substantially meeting expectations (depicted in Figure 9.5-2 as the green zone). A probationary period (the yellow zone) is provided for implementation that is falling significantly short of expectations. For the RPA to be considered in such a probationary period, NMFS must determine that corrective actions are within the Action Agencies' current authority and can and will be implemented in a timely enough manner to avoid having a significant effect on full implementation of this RPA. If the Action Agencies have critically failed by not taking identified key actions, or if the performance of one or more stocks falls below expectations to the extent that RPA expectations cannot likely be met or confirmed through correction within current authority, NMFS will issue a failure report pursuant to Section 9.5.4 (the red zone).

The following sections describe the mid-point evaluation process.

FIGURE 9.5-1. TIMELINE FOR MIDPOINT EVALUATIONS

2000

2000 Biological Opinion Jeopardy Analysis

FCRPS Performance Standards

Hydro	Offsite

2001 to 2003

3/01 9/01	Initial 5-year (02 to 06) Implementation Plan 1-year (02) and 5-year (02 to 06) Implementation Plans	2000 adult return data
9/02	1-year (03) and 5-year (03 to 07) Implementation Plans	2001 adult return data
9/03	1-year (04) and 5-year (04 to 08) Implementation Plans including the following: *Cumulative assessment of implementation *Status of research on critical uncertainties *Status of implementation of habitat pilot studies *Updated bio. goals and objectives per TRT results *Site-specific offsite mitigation plans (based on completed subbasin assessment and other finer scale analyses)	2002 adult return data

<u>2003 Progress Check-in</u>

Question 1: What is the status of 1- and 5-year plan development and implementation?

2004 to 2005

9/04	1-year (05) and 5-year (05 to 09) Implementation Plans	2003 adult return data
9/05	1-year (06) and 5-year (06 to 10) Implementation Plan including the following: *Cumulative assessment of implementation *Results of research on critical uncertainties *Preliminary results of pilot studies	2004 adult return data

NMFS reassessment of status, including population growth rates (λ)

<u>2005 Progress Check-in</u>

Question 1: What is the status of 1- and 5-year plan development and implementation?
Question 2: What is the status of stocks?
Question 3: How effective are hydrosystem actions?
Question 4: How effective are offsite mitigation actions?

2006 to 2008

9/06	1-year (07) and 5-year (07 to 11) Implementation Plans	2005 adult return data
9/07	1-year (08) and 5-year (08 to 12) Implementation Plans	2006 adult return data
9/08	1-year (09) and 5-year (09 to 13) Implementation Plans including the following: *Cumulative assessment of implementation *Results of research on critical uncertainties *Results of pilot studies	2007 adult return data

NMFS reassessment of status, including population growth rates (λ)

<u>2008 Progress Check-in</u>

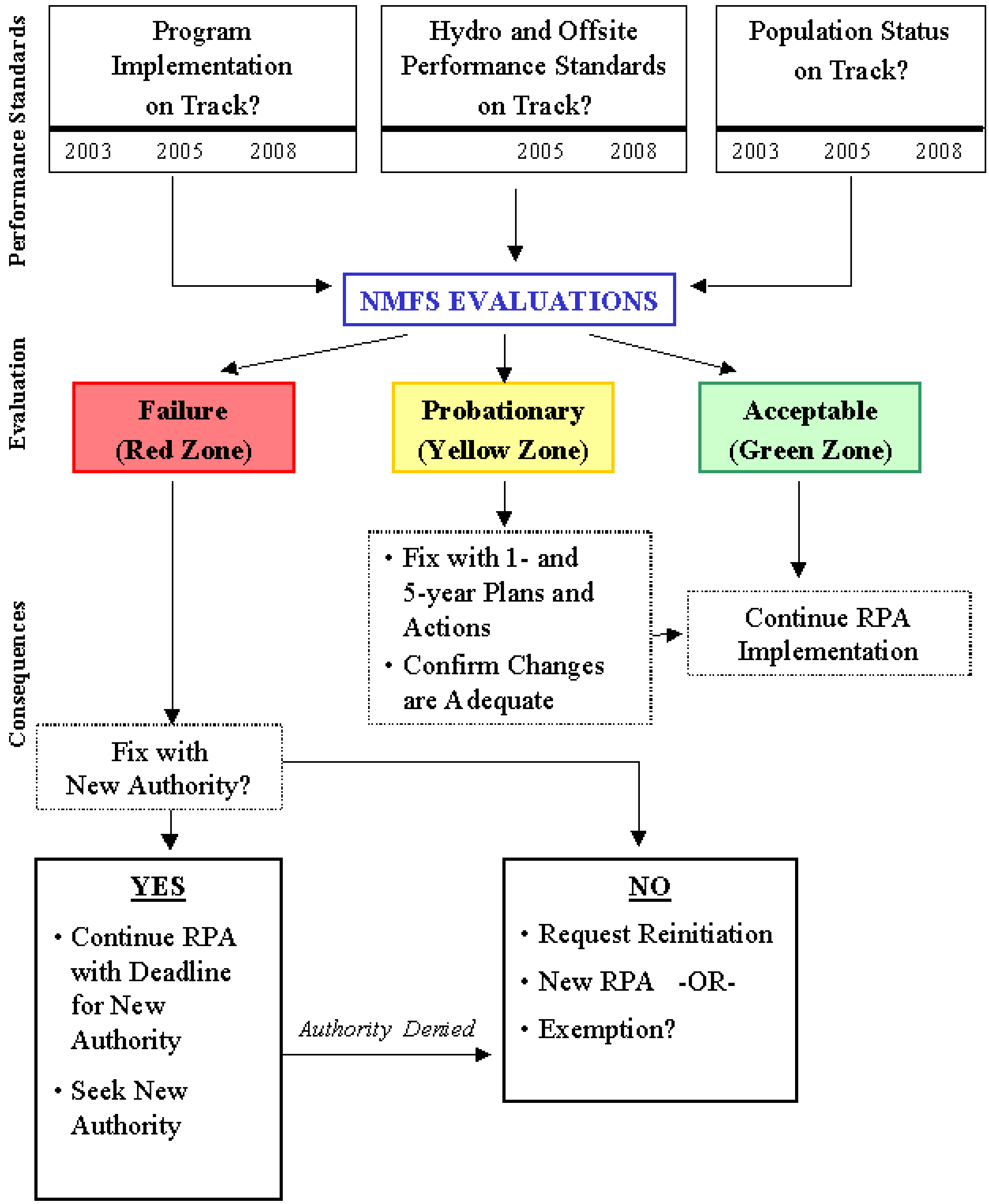
Question 1: What is the status of 1- and 5-year plan development and implementation?
Question 2: What is the status of stocks?
Question 3: How effective are hydrosystem actions?
Question 4: How effective are offsite mitigation actions?

2009 to 2010

9/09	1-year (10) and 5-year (10 to 14) Implementation Plans	2008 adult return data
9/10	1-year (11) and 5-year (11 to 15) Implementation Plans and new Biological Assessment reinitiating consultation	2009 adult return data

2011 Biological Opinion Jeopardy Analysis

Figure 9.5-2. Evaluation Flow Chart



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9.5.2 Implementation Progress Check-in 2003

9.5.2.1 Purpose

NMFS' 2003 implementation progress evaluation will focus primarily on the implementation of the RPA measures and, in particular, on the early implementation of hydro, offsite mitigation and research, monitoring, and evaluation measures that are essential to avoid jeopardy and adverse modification of critical habitat. The timely development of performance standards to evaluate the effectiveness of hydro and offsite mitigation measures by 2005 and 2008 is equally essential to ensure that the RPA continues to meet section 7(a)(2) standards. NMFS will consider whether any other new information relevant to species status indicates that the FCRPS/BOR operations are having a materially greater adverse effect than originally assessed and should be considered at this time. NMFS will also determine whether the Basinwide Recovery Strategy is being implemented in a manner likely to be effective, timely, and consistent with its scientific basis.

9.5.2.2 Contents of 2003 Annual Progress Report

In their 2003 annual progress report (due September 1, 2003), the Action Agencies will include a comprehensive and cumulative assessment of their success in implementing the actions called for in this RPA. In addition to the requirements for each annual progress report (as specified in Section 9.4.2.13), the 2003 annual progress report will document the Action Agencies' findings, developed in coordination with Federal agencies, regarding each of the following:

- Whether the Action Agencies have obtained the *funding and authorizations necessary for timely implementation of key actions* identified in this RPA and the annual planning processes and whether those actions are being implemented as expected or in a manner likely to be effective and timely as outlined in this biological opinion. Appendix F provides a summary of the actions, as of the date of this biological opinion, and the specific expectations for this progress check. Key actions are those that 1) are expected to result in near-term survival benefits for the listed stocks, 2) are preparations for implementation of additional survival improvement measures, or 3) are planning, research, and monitoring actions that are important for implementation and evaluation of progress by 2005 and 2008. These expectations are the programmatic standards against which implementation success will, in part, be evaluated. Modification of the list of actions in Appendix F is expected through the 1- and 5- year planning consistent with these criteria above.

- Whether the Action Agencies have initiated *adequate pilot studies, research, and monitoring* projects identified pursuant to Section 9.6.5.3 to confirm or rebut key assumptions. This documentation will include studies of the survival response to habitat actions identified pursuant to the RPA and the Basinwide Recovery Strategy as necessary to improve life-stage survivals of listed fish species.

- Whether *subbasin assessments* have been developed in accordance with Section 9.6.2.1 and *hatchery genetic management plans and safety net planning* have been completed pursuant to Section 9.6.4.2, as well as whether the results of these planning actions have been incorporated into site-specific plans for offsite mitigation.

- Whether the Action Agencies, in coordination with other Federal agencies, have adopted biological performance standards determined by NMFS, based on the best science available, as sufficient 1) to *evaluate the status of each ESU relative to survival and recovery indicator criteria*, using, in particular, ESU-specific recovery standards that incorporate measures of abundance, productivity trends, species diversity, and population distribution and 2) to *evaluate how effectively the actions produce survival improvements* to meet the offsite mitigation performance standard described in Table 9.2-4.

- Whether the Action Agencies have adopted detailed *site-specific, offsite mitigation plans* to meet the offsite mitigation performance standard described in Table 9.2-4, based on completed subbasin assessments, finer scale analyses, and the best available science, are implementing such plans in accordance with their provisions, and have adequate monitoring in place to evaluate their effectiveness.

- Whether the Action Agencies have established *measurable, objective physical performance standards* approved by NMFS based on the best available science to achieve habitat attributes and hatchery reforms through management actions that provide the life cycle survival improvements needed to achieve survival and recovery indicator criteria consistent with Sections 9.2.2.2.2 and 9.2.3.

- Whether the Federal agencies participating in the Federal Caucus (other than the hydro Action Agencies) have obtained the funding and authorizations necessary for the timely implementation of specific *action items identified in the Basinwide Recovery Strategy* and whether those action items are being implemented in a manner likely to be effective, timely, and consistent with the scientific basis for the Basinwide Recovery Strategy. Federal Caucus members will provide this information to NMFS and the Action Agencies as part of the Basinwide Recovery Strategy implementation.

9.5.2.3 NMFS' Evaluation of the 2003 Annual Progress Report

In 2003 NMFS shall evaluate the Action Agencies' implementation of the RPA as of that date based upon the 2003 Annual Progress Report and the best available science. NMFS will prepare an evaluation report in which it shall affirm or reject each of the Action Agencies' findings and present the basis for its evaluation.

NMFS will evaluate the implementation of Section 9.6.1 onsite FCRPS hydro actions, including the expected implementation schedule. NMFS will also evaluate the Action Agencies' success in developing 1- and 5-year plans in 2001, 2002, and 2003 and the implementation, or likely implementation, of the actions identified in those plans. NMFS' evaluation of offsite mitigation plans and description of action implementation will conclude whether or not they have been developed to a level of detail sufficient to evaluate and ensure their effectiveness. For habitat actions, this detail will be accomplished primarily through subbasin assessments and finer scale analyses; for hatchery actions, the details will be developed through hatchery genetic management plans and safety net planning. These planning activities must be completed and the results incorporated into site-specific and ESU-specific plans for offsite mitigation by the 3-year progress check. For both habitat and hatchery actions, the focus will be on early implementation priorities specified in the RPA and initial 5-year plan (due March 31, 2001). For research, monitoring, and evaluation studies, progress must include initiation of research on critical uncertainties and pilot studies to test key assumptions relating habitat improvements to life stage survival improvements for listed fish species. The pilot studies will specifically include focused efforts on intermediate stage survival (e.g., egg-to-parr and parr-to-smolt) in some carefully selected sites to provide an initial check on the effectiveness of habitat actions.

NMFS' report will determine whether, on balance, the Action Agencies' implementation of the RPA is substantially meeting expectations (green zone); not meeting expectations, but capable of timely restoration within current authority (yellow zone); or failing, although possibly rectifiable with additional authority (red zone) (Figure 9.5-2). The report will explain the basis for its determination using the best science available.

If the evaluation report shows that the implementation is neither timely nor sufficient, or is not adequate to address new information about species status, NMFS will determine whether the deficiency can be remedied by actions within current authority (i.e., the yellow zone). If NMFS determines that actions exist, within the full authority and capability of the Action Agencies, that can restore the timely and complete implementation of the RPA to the extent necessary to meet the expectations for the 2005 and 2008 check-in evaluations, then NMFS will indicate how the Action Agencies can revise RPA implementation through new 1- and 5- year plans to meet the hydro and off-site performance standards. For example, the plans could call for further efforts to reduce hydro system mortality.

If NMFS determines that the insufficiency of the Action Agencies' RPA implementation cannot be remedied through changes to the 1- and 5- year plans, NMFS will issue a failure report.

Insufficient implementation of key actions (see Section 9.5.2.2 and Appendix F) would necessarily result in a failure report. NMFS' failure report will identify any actions, in particular those not currently authorized for implementation by the Action Agencies, that NMFS has determined are necessary for the FCRPS and BOR projects to avoid jeopardizing the listed species and adversely modifying their critical habitat. The Action Agencies would then seek and obtain additional authority from congress to ensure that the actions continue to avoid jeopardy and adverse modification of critical habitat. For example, failure to implement enough estuary or tributary habitat improvements for Snake River ESUs could necessitate that the Action Agencies seek authorizations to breach Snake River dams (while continuing efforts to restore estuary and tributary habitat) to ensure that all options are available at the mid-point evaluation in 2005. If such actions exist, NMFS will also determine whether all of the listed salmonid ESUs are likely to survive, while retaining an adequate potential to recover, during the time reasonably necessary to obtain required authority and implement the action(s). If NMFS determines that even those additional actions would be insufficient, it may recommend reinitiation of consultation. The Action Agencies also may reinitiate consultation.

Because only limited, new empirical data and analyses are likely to be available in 2003, NMFS does not anticipate reassessing the jeopardy analysis during this evaluation, nor is a scientific peer review of the evaluation report likely to be warranted.

Failure to implement the RPA may also have consequences for consultations on other Federal agency actions that affect listed species in the Columbia River basin, particularly hatchery management and those actions that may affect the estuarine or tributary habitat of the affected ESUs.

9.5.3 The 2005 Evaluation

9.5.3.1 Purpose

In 2005, as in 2003, NMFS will check on the implementation of the key RPA measures. In this check-in, however, the status of the listed salmonid ESUs and biological and physical performance standards will be of equal importance to implementation actions. NMFS will reevaluate the listed ESUs based on performance standards, new monitoring data, results of research on critical uncertainties, and initial results from pilot studies. NMFS will assess whether the population growth rates are improving relative to the levels estimated in 2000 and whether population abundance levels are consistent with standards established in the RPA (see Section 9.2.2.1).

9.5.3.2 Contents of the 2005 Annual Progress Report

The Action Agencies shall provide the best available scientific information regarding each of the topics required for the 2003 annual progress report and, in particular, will include full and complete information about the issues presented in the subsections below.

9.5.3.2.1 Status of 1- and 5-year plan development and implementation. The Action Agencies shall update the information that was required for the 2003 check-in evaluation (see Section 9.5.2.2). NMFS expects that substantially more information about RPA implementation will be available in 2005. In particular this review will assess the timely and sufficient completion of key actions as prescribed by this RPA.

9.5.3.2.2 Status of the listed stocks. Enough new data shall be provided to allow NMFS to apply the performance standards provided in Section 9.2.2.1, including the abundance, productivity trends, species diversity (genetic and life history diversity), and population distribution for each listed ESU.

9.5.3.2.3 Effectiveness of hydrosystem actions. The Action Agencies shall provide enough information for NMFS to complete a thorough review of the adequacy of hydrosystem actions taken, a revision of juvenile and adult hydrosystem survival estimates, evaluations of delayed mortality of transported fish and inriver migrants, and assessments of the ability to improve juvenile fish passage survival through actions taken under the RPA, e.g., surface bypass development and evaluations of the effectiveness of 24-hour spill. Such evaluations should more clearly define the potential effectiveness of breach, transport, and inriver alternatives. The Action Agencies will document their conclusions as to whether they are making adequate progress to reach full attainment of the hydro performance standard by 2010.

9.5.3.2.4 Effectiveness of off-site mitigation actions. The Action Agencies shall review the offsite actions that have been implemented, list their benefits (specific to each ESU), and assess those offsite actions that are planned for implementation. The Action Agencies will provide enough information to enable NMFS to verify their findings and draw conclusions regarding the following key evaluations:

- Have the Action Agencies demonstrated (through pilot studies, historical data assessments, and implementation monitoring) that proposed actions can increase life stage survivals?

- Are the actions with demonstrated survival improvements being implemented at a scale sufficient to avoid jeopardy for each population and each ESU as appropriate, in light of the effects of all other actions that may affect the relevant population and ESU?

9.5.3.3 NMFS' Evaluation of 2005 Annual Progress Report

In 2005, NMFS will issue its evaluation affirming or rejecting each of the Action Agencies' findings in the annual report described above and will conduct comprehensive evaluations of Action Agency activities (and those of cooperating parties), the results of pilot studies, and the results of research on critical uncertainties. NMFS will also develop a complete reassessment of the status of each ESU, including population growth rates (e.g., lambda), abundance, geographic distribution, genetic diversity, and life history diversity. This reassessment will include a specific review of performance relative to the survival and recovery indicator criteria. For the 2005 evaluation, the performance standards specified in Section 9.2 must be satisfied for this RPA to be considered successful.

As part of the review, NMFS will incorporate any additional information available through the 2004 returns and, for populations representative of each ESU, will provide the following:

- An updated extinction risk analysis based on estimates of the population growth rates (e.g., lambda) from 1980 to the present and incorporating updated estimates of abundance

- An extinction risk analysis based on estimates of the population growth rates (e.g., lambda) from the most recent year for which adult return data are available, going back a long enough time to make an adequately precise estimate (approximately 10 to 12 years)

- Expected population growth rates, abundance, distribution, and resulting extinction risks based on implementation of the RPA, specifying the effects attributable to offsite mitigation (including pilot studies) and the combined effects of all other actions (e.g., from the Basinwide Recovery Strategy) that may affect the populations

- Estimates of survival gains necessary to achieve recovery/survival indicator criteria

NMFS anticipates that methods of assessing annual population growth rates will have been refined, based on NMFS' research efforts, those of the Action Agencies, or those of independent scientists. In anticipation of this normal progress in scientific methods, NMFS does not now define a specific method by which population growth rate will be determined for its mid-point evaluations. By March 1, 2005, NMFS will choose the most appropriate method(s) to estimate population growth rate from the peer-reviewed literature, based on collaboration with the Action Agencies, USFWS, and the state and Tribal comanagers.

By 2005, the Action Agencies must have implemented the hydro, habitat, and hatchery projects specified in 1- and 5-year plans. In addition, the Action Agencies must have initiated research on critical uncertainties and implemented pilot studies to evaluate offsite mitigation benefits, particularly the kinds of life-stage-specific survival improvements that can be expected from their implementation. Based on best available science, NMFS will calculate expected future population growth rates and conclude whether the expected rates are consistent with the estimated level of improvement needed to achieve the survival and recovery indicator criteria. To do this, NMFS will use the improved information on project effectiveness from the pilot studies and improved information on the extent of implementation from the progress reports and compliance monitoring to estimate life-stage-specific survival improvements for all populations. Physical performance standards will remain important as measures of RPA effectiveness for habitat and hatcheries because of the lag times between these habitat actions and population response.

NMFS' report will document its findings related to all available measures of the status of the ESUs (e.g., abundance, distribution, and diversity), including those developed through the technical recovery team process for recovery planning. As the data available in 2005 may be too preliminary for conclusive analysis, NMFS may also recommend measures to refine its preliminary findings no later than the 2008 evaluation.

If the evaluation report finds the implementation is on track (i.e., in the green zone) then implementation will proceed unchanged. If NMFS' evaluation finds that implementation is neither timely nor sufficient, or if NMFS finds that the status of one or more of the listed species has worsened, it will determine whether the insufficiency falls into the probationary yellow zone. If it does, NMFS will then identify how the Action Agencies can revise their implementation through new 1- and 5-year plans to meet the hydro and offsite performance standards. For example, the plans could call for further efforts to reduce hydro system mortality, such as improved flow and spill. Also, if the Action Agencies have obtained additional authority (such as dam breaching authority [see Section 9.6.1.9]) pursuant to direction from the 2003 check-in, they may rectify the RPA's performance by exercising such authority immediately.

If NMFS determines that the RPA's implementation problems cannot be rectified through actions provided in 1- and 5-year plans, it will issue a failure report. The failure report will identify any actions not currently authorized for implementation by the Action Agencies, but that NMFS determines are consistent with the purposes of the FCRPS, technologically and economically feasible, and required to enable the FCRPS and BOR projects to be most likely to avoid jeopardizing the listed species and adversely modifying their critical habitat. The Action Agencies would have to seek and obtain additional authority from congress to ensure that they could continue to avoid jeopardy and adverse modification of critical habitat. For example, failure to implement enough of the estuary or tributary habitat improvements required for Snake River ESUs could mean that the agencies would have to seek authorizations to breach Snake River dams (while continuing efforts to restore estuary and tributary habitat) to ensure that all options are available at the next evaluation in 2008. If other such actions exist, NMFS would also determine whether all of the listed salmonid ESUs are likely to survive, while retaining an adequate potential to recover, during the time needed to obtain the required authority and to implement the action(s).

If NMFS determines that even those additional actions would be insufficient (red zone), it may recommend reinitiation of consultation. The Action Agencies also may reinitiate consultation.

Failure to implement the RPA may also have consequences for consultations on other Federal agency actions that affect listed species in the Columbia River basin, particularly hatchery management and those actions that may affect the estuarine or tributary habitat of the affected ESUs.

9.5.4 The 2008 Evaluation

9.5.4.1 Purpose

Although RPA implementation will still be important in 2008, achievement of performance standards, including the performance of the listed salmonid ESUs will be of primary concern in the 2008 evaluation. NMFS will reconsider all aspects of the evaluations made in 2003 and 2005, based upon the best scientific data available by 2008. In addition, NMFS will assess the population effects attributable to the measures implemented since 1995, based, in particular, on fish returns since 1995; life-stage survival improvements, including hydro survival improvements; and physical performance standards, especially for habitat and hatchery actions.

9.5.4.2 Contents of the 2008 Annual Progress Report

The Action Agencies will provide, in coordination with NMFS and USFWS, the information, findings, and conclusions for every element required in the 2005 evaluation, representing the best scientific data and analysis available by 2008.

9.5.4.3 NMFS' Evaluation of the 2008 Annual Progress Report

In 2008, NMFS will update and refine the analyses it performed for the 2005 evaluation based on the best science and analysis available by 2008. In addition, NMFS will estimate those conditions and population trends attributable to the significant changes in operations initiated with the 1995 biological opinion. Other measures of the status of the ESUs will also be evaluated, as defined through the recovery planning process. NMFS will issue its evaluation report, affirming or rejecting each of the Action Agencies' findings in the annual report, documenting its findings concerning the success or failure of the Action Agencies' implementation of the RPA. In particular, the 2008 evaluation must conclude that the performance standards specified in Section 9.2 are satisfied for the implementation of this RPA to be considered successful.

NMFS anticipates that methods of assessing annual population growth rates will have been refined, based on NMFS' research efforts, those of the Action Agencies, or those of independent scientists. In anticipation of this normal progress in scientific methods, NMFS does not now define a specific method by which population growth rate will be determined for its mid-point evaluations. By March 1, 2008, NMFS will choose the most appropriate method(s) to estimate population growth rate from the peer-reviewed literature, based on collaboration with the Action Agencies, USFWS, and the state and Tribal comanagers.

By 2008, habitat, hatchery, and hydro projects specified in the 1- and 5-year plans must have been implemented, and pilot studies should continue to validate the kinds of life-stage-specific survival improvements that can be expected from their implementation. Physical performance standards will remain important due to lag times between these actions and population response. NMFS will have improved information on project effectiveness from the pilot studies and on the extent of implementation from the progress reports and compliance monitoring to estimate life-stage-specific survival improvements for all actions to be credited with such improvements and for all populations. Based on this information, NMFS will calculate expected future population growth rates and conclude whether or not the expected rates are consistent with the level of improvement estimated to be necessary to achieve the survival and recovery indicator criteria.

If NMFS determines that RPA implementation is not timely or sufficient, or if it finds that the status of one or more of the listed species has changed materially for the worse, NMFS will determine whether the RPA implementation can be revised through the 1- and 5-year planning process to meet the hydro and offsite performance standards. If so, the RPA implementation will be considered to be in the yellow zone, as in Figure 9.5-2, above. If the RPA can be restored, NMFS will recommend additional measures to address the changed status of the affected ESU(s) or the effects of inaction upon the ESU(s). For example, the plans could call for further efforts to reduce hydro system mortality, such as improved flow and spill. Also, if the Action Agencies have obtained additional authority, including dam breaching authority, pursuant to direction from the 2003 or 2005 check-ins, they may restore the RPA's performance by exercising such authority immediately.

If NMFS finds that any of the listed salmonid ESUs have failed to perform as expected by 2008 (see Section 9.2), it will conclude that the RPA is in the red zone, unless enough authority has become available for implementation in 2008. If NMFS determines that the RPA implementation cannot be remedied through changes to the 1- and 5-year plans, NMFS will issue a failure report. The failure report will identify any actions not currently authorized for implementation by the Action Agencies, but that NMFS determines are technologically and economically feasible, consistent with the purposes of the FCRPS and necessary to enable the FCRPS and BOR projects to be likely to avoid jeopardizing the listed species and adversely modifying their critical habitat. A failure report from NMFS, identifying such actions, would require the Action Agencies to seek and obtain additional authority from congress to ensure that the agencies continue to avoid jeopardy and adverse modification of critical habitat. For example, failure to implement estuary or tributary habitat improvements required for Snake River ESUs could mean that the agencies would have to seek authorizations to breach Snake River dams (while continuing efforts to restore estuary and tributary habitat). If NMFS determines that even those additional actions would be insufficient, it may recommend reinitiation of consultation. The Action Agencies may also reinitiate consultation.

Failure to implement the RPA may also have consequences for consultations on other Federal agency actions that affect listed species in the Columbia River basin, particularly hatchery management and those actions that may affect the estuarine or tributary habitat of the affected ESUs.

9.5.5 Procedural Options after a Yellow Zone or Red Zone Evaluation Report

At any of the evaluation points, NMFS may conclude that the RPA, as implemented by the Action Agencies, fails, or is in danger of failing, to satisfy the ESA Section 7(a)(2) requirement to avoid jeopardy and adverse modification of critical habitat for any of the listed species affected by the covered actions. In other words, NMFS may determine that the Action Agencies' implementation is in the yellow or red zones (see Figure 9.5-2). At year 3, that conclusion would most likely be based on failure of the Action Agencies to fully implement the actions called for in the RPA and its 1- and 5-year planning process. At years 5 or 8, this conclusion would be based primarily on the results of an updated jeopardy analysis, taking into account the current status of the listed species and the effectiveness of the RPA measures. At the 3-, 5-, or 8-year check-in, in a red zone situation, a determination can be made, under certain conditions, to pursue authority to breach one or more dams or to seek authorization and appropriations for additional actions necessary to address the situation for stocks that would not benefit from dam breaching. The procedures to address this situation are described in the next section.

9.5.5.1 1- and 5-Year Plan Amendments

The RPA is designed to respond to new information within the authority of the Action Agencies. Through the 1- and 5-year planning process, shortfalls in the performance of the RPA measures or adverse changes in the species' status must, at a minimum, be adequately addressed by plan modifications. If, for example, the Action Agencies implement a measure that is not effective, or they are unable to implement an expected measure, the planning process requires them to identify alternative measures, within their full authorities, to provide the necessary survival benefits to the listed species. The annual progress reports and the mid-point evaluations must ensure that such shortfalls are adequately addressed. Similarly, if the status of the stocks changes or is worse than originally assessed, the Action Agencies may identify additional RPA measures in their planning processes to ensure that the RPA will have the expected results. NMFS must ensure that enough scientific basis exists to ensure that the additional RPA measures will produce the results expected. Improvement in stock status that is due primarily to environmental variation, such as improved ocean conditions or high runoff years, will not be a basis for curtailing measures intended to address anthropomorphic factors for decline.

9.5.5.2 Continuance to Obtain Authority or Appropriations

If NMFS finds that the RPA fails to meet ESA Section 7(a)(2) standards despite the Action Agencies' exercise of their current authority, and thus the RPA is in the red zone, NMFS will identify additional actions that would satisfy those standards if implemented by the Action Agencies, even though the Action Agencies lack the necessary authority and/or appropriations. Such actions would likely include the breach of one or more dams for those Snake River stocks that would benefit from such actions. As of the date of this biological opinion, dam breaching may significantly improve the survival of Snake River ESUs and is a potential remedy for a failure to achieve performance standards, due to implementation failure or an adverse change in stock status, for the Snake River ESUs. Thus, this biological opinion presumes that the Action Agencies would have to seek this additional authority for Snake River ESUs in the red zone. For Mid-Columbia and Upper Columbia ESUs, a comparable remedy may be appropriate, though the state of the science is not as well developed as of the date of this biological opinion. NMFS will make this red zone determination using the best science available at the time.

NMFS must be able to find, using the best science available, that the Action Agencies' continuing implementation of the RPA, as detailed in the 1- and 5-year plans, satisfies ESA Section 7(a)(2) standards for a long-enough time to obtain and exercise the necessary authority and appropriations. This is particularly appropriate for FCRPS and BOR projects because their operation is ongoing and cannot be stopped while new authority is obtained. In this situation, therefore, the Action Agencies may seek the authority and/or appropriations for the necessary measures, within the time specified by NMFS. During this time, they would otherwise continue to implement the RPA. Continued implementation of the RPA would remain essential to the survival of all ESUs in life stages not affected by dam breaching. NMFS' report, prepared in coordination with the Action Agencies, would provide the available scientific and technical data and analysis demonstrating the likely feasibility and effectiveness of the measure. Failure to obtain the requisite authority or appropriation within the specified time period would trigger a reinitiation of this consultation.

9.5.5.3 Reinitiation of Consultation

If NMFS finds that the RPA, as implemented, fails to avoid jeopardy to the listed species or adverse modification of their critical habitat, and neither of the preceding procedural options is available, this consultation must be reinitiated pursuant to Chapter 13 and the consultation regulations at 50 CFR Section 402.16. During a reinitiation of consultation, NMFS would reapply the ESA Section 7(a)(2) standards to the effects of the RPA implemented by the Action Agencies. In a new biological opinion, NMFS would reassess the status of the listed species, taking into account the likelihood of survival and recovery as affected by actions across the life cycle of each listed species. NMFS must conclude whether there is any RPA that avoids jeopardy as defined in 50 CFR Section 402.02. If not, then NMFS would document that, after a good faith, reasonable, and responsible effort, no RPAs could be developed within the authority of the Action Agencies, thereby making the actions covered by this opinion eligible for an ESA exemption.

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9.6 MEASURES TO AVOID JEOPARDY

9.6.1 Hydro Measures

9.6.1.1 Overview

Operational and structural fish passage improvements at FCRPS projects are proposed to increase the survival of listed fish. This section describes the specific hydro measures that NMFS has determined, based on the best scientific information, to be as follows:

- Biologically feasible and implementable
- Sufficient to achieve performance standards that represent the best the hydrosystem can do without dam breaching
- Sufficient to result in a high likelihood of survival and a moderate-to-high likelihood of recovery, combined with offsite mitigation defined in Sections 9.6.2, 9.6.3, and 9.6.4 of this biological opinion and with other improvements affecting the listed species described in the Basinwide Recovery Strategy

The hydrosystem measures are expected to reduce juvenile and adult salmonid mortality attributable to passage through the hydrosystem and to attain the hydro performance standards by 2010. Their main features are described briefly below.

Proposed measures for improving water management so as to provide direct and indirect survival benefits to salmon include the following:

- Meet flow objectives at Lower Granite, Priest Rapids, McNary, and Bonneville dams.
- Provide in-season management for operational flexibility and best use of available water volumes.
- Provide guidance on reservoir elevations in early spring, early summer, and at the end of the summer flow augmentation season.
- Coordinate with water releases from Canada, the upper Snake River, and the Hells Canyon Complex.
- Take specific actions to improve water management for salmon: 1) additional drafts of selected FCRPS reservoirs, 2) additional water from other sources, 3) shifts of flood control among projects, 4) implementation of VARQ flood control operations at Libby and Hungry Horse reservoirs, 5) review of system flood control objectives, and 6) continued research on summer-migrating SR fall chinook salmon population losses.

The following actions are prescribed for improving juvenile passage survival through the FCRPS to the ocean:

- Increase spillway passage using gas abatement and longer spill hours to allow greater spill volumes; also, refine spill patterns and evaluate removable spillway weirs (RSWs) as ways of improving spill efficiency.

- Conduct research on spillway passage to identify additional potential survival and passage improvements.

- Increase screen/bypass system effectiveness with extended screens, new outfalls, and improved hydraulic conditions.

- Develop and test surface bypass technology, with implementation as appropriate.

- Provide improved turbine designs and operating guidelines.

- Improve passage system operations and reliability.

Measures for improving juvenile reservoir survival, and thereby increasing the survival of downstream migrating salmon, include the following:

- Increase flow augmentation for summer migrants, particularly in the low water years.

- Manage reservoir and run-of-river projects to reduce extreme water level fluctuations.

- Manage predator populations (fishes, birds, and mammals).

Measures for improving adult survival are as follows:

- Develop actions to reduce fallback through turbines and over spillways.

- Increase facility reliability and the ability to maintain operating criteria.

- Investigate measures to protect steelhead kelts.

- Investigate prespawning mortality.

Measures for improving water quality include the following:

- Make structural and operational modifications at spillways (e.g., spillway deflectors, improved spill patterns) to help reduce TDG levels.

- Develop alternative fish passage measures (e.g., surface bypass).
- Release cool water from storage reservoirs (e.g., Dworshak Dam).
- Institute special powerhouse operations (e.g., McNary Dam).

NMFS proposes active investigation to reduce or resolve key uncertainties. Critical uncertainties relate primarily to the hypothesis of delayed mortality due to passage through the hydrosystem:

- Investigate delayed mortality of transported juvenile migrants (D-value when expressed relative to the survival of nontransported migrants below Bonneville Dam).
- Investigate delayed mortality of inriver juvenile migrants (extra mortality).
- Investigate delayed mortality or passage effects on adults.
- Investigate estuarine/ocean survival.

Measures are also proposed for enhanced O&M of fish passage facilities. Developing appropriate annual budgets through the annual 1- and 5-year planning process will help ensure continued high performance of fish passage facilities. Preventive maintenance planning and day-to-day operation of fish passage facilities can be improved by an increased commitment to excluding debris and operating within identified criteria.

NMFS believes the strength of these measures depends not only upon scientific analysis, but also on the joint decision-making processes defined in Section 9.4. Involvement and input from the region's fish and wildlife managers and Indian Tribes are necessary to ensure that all of the best scientific and technical information is considered in the effort to avoid jeopardy.

9.6.1.2 Water Management

9.6.1.2.1 Flow Management Objectives in Mainstem Columbia and Lower Snake Rivers

Action 14: The Action Agencies shall operate FCRPS dams and reservoirs with the intent of meeting the flow objectives (Table 9.6-1) on both a seasonal and weekly average basis for the benefit of migrating juvenile salmon.

This flow-management program uses three strategies:

- Limit the winter/spring drawdown of storage reservoirs to increase spring flows and the probability of reservoir refill.
- Draft from storage reservoirs during the summer to increase summer flows.

Table 9.6-1. Seasonal flow objectives and planning dates for the mainstem Columbia and Snake rivers.

	Spring		Summer	
Location	**Dates**	**Objective**	**Dates**	**Objective**
Snake River at Lower Granite Dam	4/03 - 6/20	85 - 100[1]	6/21 - 8/31	50 - 55[1]
Columbia River at McNary Dam[2]	4/10 - 6/30	220 - 260[1]	7/01 - 8/31	200
Columbia River at Priest Rapids Dam	4/10 - 6/30	135	NA	NA
Columbia River at Bonneville Dam	11/1-emergence	125–160[3]	NA	NA

[1] Objective varies according to water volume forecasts (see below).
[2] NMFS is contemplating moving the flow measurement location from McNary Dam to Bonneville or The Dalles dam by creating new objectives for Bonneville Dam (Conservation Recommendation 11.5).
[3] Objective varies based on actual and forecasted water conditions.

- Provide minimum flows in the fall and winter months to support mainstem spawning and incubation below Bonneville Dam.

Under the first strategy, the FCRPS storage reservoirs are operated to ensure a high probability of water surface elevations within 0.5 foot of the flood control rule curve by April 10 and to refill by June 30, except as specifically provided by the Technical Management Team. Before the 1995 Biological Opinion, FCRPS storage reservoirs were routinely drafted well below these levels to maximize hydropower generation during the fall and winter. Meeting the spring flow objectives occasionally requires reservoir drafting, but the spring flow objectives are primarily met by limiting winter drafting and reservoir refill rates. This operation allows for a more natural spring hydrograph by passing spring runoff through the storage reservoirs.

The second strategy is used to facilitate summer operations. FCRPS storage reservoirs are drafted as necessary within specified limits in an attempt to meet the summer flow objectives and to provide colder water for the benefit of migrating juvenile salmonids. These operations may also benefit adults in passage by moderating temperatures.

The third strategy has recently been integrated into the overall flow management objective to provide habitat for mainstem spawning chum and fall chinook. It includes subsequent flows to protect the redds from dewatering through their emergence in the spring, to the extent possible without impacting refill probabilities of FCRPS storage projects and spring flow objectives.

Data collected to date regarding the effects of flow on survival of fall chinook juvenile migrants (NMFS 2000h) indicate that flows ranging from 80 to 100 kcfs measured at Lower Granite Dam during the summer migration period would be optimal for these fish. Although juvenile fall chinook survival is correlated with streamflow, survival shows similar correlations to water temperature and turbidity (NMFS 2000h). For this reason, water quality, particularly water temperature, should be considered in determining the optimum use of available stored water volumes for flow augmentation in the Snake River. NMFS is not revising the Snake River summer flow objectives to an 80- to 100-kcfs range at this time. The existing seasonal flow objectives established by the 1995 FCRPS Biological Opinion (NMFS 1995a) represent a fair balance between flow and water quality conditions.[6]

Spring Flows at Lower Granite Dam. Based on the April final runoff volume forecast at Lower Granite Dam for April to July, spring flow objectives will be determined as follows:

- When the volume forecast is less than 16 Maf, the flow objective will be 85 kcfs.

- When the volume forecast is greater than16 Maf and less than or equal to 20 Maf, the flow objective will be determined by a linear interpolation between 85 kcfs and 100 kcfs.

- When the volume forecast is greater than 20 Maf, the flow objective will be 100 kcfs.

Summer Flows at Lower Granite Dam. Based on the June final runoff volume forecast at Lower Granite Dam for April to July, summer flow objectives will be determined as follows:

- When the volume forecast is less than 16 Maf, the flow objective will be 50 kcfs.

- When the volume forecast is greater than 16 Maf and less than or equal to 28 Maf, the flow objective will be determined by a linear interpolation between 50 kcfs and 55 kcfs.

- When the volume forecast is greater than 28 Maf, the flow objective will be 55 kcfs.

Spring Flows at McNary Dam. Based on the April final runoff volume forecast at The Dalles Dam for April to August, spring flow objectives will be determined as follows:

- When the volume forecast is less than 80 Maf, the flow objective will be 220 kcfs.

- When the volume forecast is greater than 80 Maf and less than or equal to 92 Maf, the flow objective will be determined by a linear interpolation between 220 kcfs and 260 kcfs.

- When the volume forecast is greater than 92 Maf, the flow objective will be 260 kcfs.

Spring Flows at Priest Rapids Dam. The spring flow objective at Priest Rapids Dam will be 135 kcfs.

[6]The issue of providing water from BOR's upper Snake basin and Idaho Power Company's Hells Canyon projects to assist in achieving Snake River flow objectives will largely be addressed in separate, ongoing Section 7 consultations.

Summer Flows at McNary Dam. The summer flow objective at McNary Dam will be 200 kcfs. The best biological information supports flows of 200 kcfs for subyearling chinook salmon in the lower Columbia River. If the numbers of juvenile fish migrating during late August decrease sharply, however, the Technical Management Team should consider preserving some of the flow augmentation water to support the fall spawning operation below Bonneville Dam.

Action 15: The Action Agencies shall operate the FCRPS to provide flows to support chum salmon spawning in the Ives Island area below Bonneville Dam.

A spawning operation will be implemented as described below if the best hydrologic data available by early October indicate that precipitation, runoff, and reservoir storage are likely to support the operation from the start of spawning (late October or early November) until the end of emergence (generally through the start of the spring flow augmentation season in April). The spawning operation cannot adversely affect implementation of this RPA or the parties' ability to comply with the Vernita Bar agreement. That agreement protects natural production of unlisted fall chinook in the Columbia River Hanford Reach. If these conditions cannot be met, the Action Agencies will work with NMFS and regional salmon managers to identify operations that would benefit salmon while maintaining these other fish protection measures. Such operations may include intentional flows below what is necessary for mainstem spawning to discourage redds from being established in the area.

Real-time operating decisions will be made through the in-season management process described in Section 9.4. The Technical Management Team will recommend a managed daily average discharge level as information on natural flows and reservoir storage becomes available. The operation for Columbia River mainstem spawning chum salmon will include the following considerations:

- If the operation complies with the conditions described above, it will begin when chum salmon are found in the area around Ives and Pierce islands, but no later than November 1. From November 1 through December 31, FCRPS storage will be used to shape or augment natural flow to a 125 kcfs minimum instantaneous discharge from Bonneville Dam. To prevent spawning in areas that could be subsequently dewatered, the Action Agencies will maintain peak flows within 5 kcfs of the established minimum. For example, if the minimum flow is 125 kcfs, the instantaneous maximum would be 130 kcfs.

- NMFS recognizes that access to spawning habitat in the Ives Island area is primarily a function of the water surface elevation in the Ives Island and Pierce Island areas. Water surface elevation, is in turn, influenced by tides, flow of the Willamette River and discharge from Bonneville Dam. If the established managed discharge cannot be maintained on an instantaneous basis (e.g., during a low spring tide), the Action Agencies will manage FCRPS operations to maintain the water surface elevation in the Ives Island area above the highest redd established by the protection level developed through the in-season management process. There may be times when this is best accomplished by managing to a Bonneville Dam tailwater gage height rather than to a flow level.

- When reservoir storage, baseflows, and predicted hydrologic conditions permit, a managed instantaneous minimum discharge greater than 125 kcfs may be adopted through coordination with NMFS and the Regional Forum. If such a higher minimum discharge is adopted, the Action Agencies will manage storage with natural flow to provide peak flows within 5 kcfs of the established minimum.

- During incubation and emergence (January 1 through the start of the spring flow augmentation program for the lower Columbia River on April 10), the Action Agencies will manage storage with natural flows to maintain the daily minimum discharge from Bonneville Dam or the adequate water surface elevation needed to protect the highest redd established by the operation and to maintain connectivity between spawning habitat and the mainstem for outmigrants. For example, if the highest redd established by the spawning operation was at an elevation corresponding to a Bonneville outflow of 125 kcfs, a discharge of at least 125 kcfs would be maintained through incubation and emergence. For all managed spawning flows 135 kcfs and above, the highest spawning flow minus 10 kcfs will be the managed minimum discharge during incubation and emergence. The highest managed daily average discharge that will be provided during the incubation and emergence period is 150 kcfs.

A restriction of a 5 kcfs flow range below Bonneville Dam may not be possible at all times. Hydropower operators have shaped flows to nighttime hours to keep spawning below targeted elevations in the mid-Columbia River. This shaping of flows (reverse load factoring) has proved effective in managing the elevations at which fall chinook salmon spawning occurs. However, the effect of shaping nighttime flows on limiting the spawning behavior of chum salmon has not been documented. To the extent that exceedances of the 5 kcfs range are unavoidable, night exceedances are preferable to day exceedances. Evaluation of the effect of shaping higher flows to nighttime hours on chum spawning behavior should be conducted. The Action Agencies should evaluate the effect when nighttime flows exceed the recommended flow range until such effects are better documented.

Several states noted that fluctuations in discharge from Bonneville Dam result in stranding of juveniles in the Ives Island complex. The extent and effect of these flow fluctuations is being assessed through an ongoing research program, and a preliminary recommendation for a ramping rate has been proposed. Continued evaluation of the need for an operation to limit juvenile stranding is required. When adequate information is developed, the appropriate operation shall be specified in the annual and 5-year hydro operations plan.

If in-season data on reservoir elevations and forecasted inflow indicate that operating FCRPS storage reservoirs to provide the flows specified above during chum incubation and emergence would jeopardize the ability to meet RPA items above and/or the ability of parties to comply with the Vernita Bar agreement, the instantaneous minimum Bonneville outflow will be reduced as necessary to meet these requirements. The Action Agencies will ensure that flow reductions are coordinated through the Technical Management Team to ensure that adverse effects are minimized and to facilitate the development of emergency actions.

The provision of flow to support chum spawning creates a need to provide continual flow through the FCRPS to maintain the redds established below Bonneville Dam during the managed spawning operation. Hydrosystem modeling results suggest that conflicts will occasionally arise between providing the quantity of flow required to maintain established redds and the need to reduce discharge from Grand Coulee to achieve refill to the spring upper rule curve elevation. This potential conflict will be resolved on an annual basis. In general, achieving upper rule curve elevation by April 10 will be a higher priority.

Several states expressed concern that the flows being provided during the chum operation were minimal. Conversely, the Tribes commented that a flow of 125 kcfs is all that should be provided. NMFS maintains that an incremental approach of starting flows at 125 kcfs and increasing them as local base flows rise with seasonal precipitation is reasonable. This management approach provides connectivity with tributary spawning habitat, provides a percentage of mainstem spawning habitat, allows spring reservoir management objectives to be met with a high level of confidence, and is consistent with the concept that offsite mitigation can provide significant benefits to the chum population.

Action 16: The Action Agencies shall operate the FCRPS to provide access for chum salmon spawning in Hamilton and Hardy creeks.

During years when there is insufficient water in storage to maintain a mainstem spawning flow of at least 125 kcfs throughout the spawning season, enough flow will be provided during the chum spawning season at times to allow access to tributary creeks. Under these conditions, the Technical Management Team will develop a recommended operation through the in-season management process.

9.6.1.2.2 Planning and Management of Available Water to Support Mainstem Flow and Spill Objectives

Action 17: The Action Agencies shall coordinate with NMFS, USFWS, and the states and Tribes in preseason planning and in-season management of flow and spill operations. This coordination shall occur in the Technical Management Team process (see Section 9.4.2.2).

Flow objectives serve as a guide to manage available water resources during the juvenile and adult migration seasons and to provide a reference for comparing various operational scenarios that may affect inriver migration conditions. They are not hard constraints. Hydrologic conditions and other constraints may preclude meeting these objectives at all times. These objectives may not represent optimal conditions and, therefore, may be exceeded if that is deemed the optimal use of water resources after considering the effects on all listed species. Likewise, flow augmentation should not be stopped or diminished once a seasonal average is met. Rather, the flow objectives provide general guidance to the Action Agencies and the Technical Management Team, discussed in Section 9.4.2.2, for in-season management considerations. Because water resources are insufficient to meet the fish flow objectives at all times under all conditions, in-season water management will strive to provide the greatest possible biological benefit from the available storage volumes and system flexibility. Although meeting the flow objectives is an important consideration, it is not an end in itself. The flow objectives are but one of many factors to consider when making decisions about river operations to benefit listed fish. The dates indicated in Table 9.6-1 are for planning purposes. Actual timing of flow measures will be determined in-season by the Technical Management Team.

The Action Agencies have multiple responsibilities affecting hydrosystem operations, including flood control, power production, protection of anadromous and resident fishes and wildlife, navigation, recreation, and irrigation, among other uses. In making operational decisions to meet other FCRPS project purposes and regulatory requirements, the Action Agencies will take all appropriate actions within their authorities to protect listed salmonids.

Several states and Tribes expressed the belief that flow objectives should be hard constraints and that this biological opinion makes too little progress toward securing the necessary water volumes to meet the flow objectives consistently. NMFS' direction to the Action Agencies is for the FCRPS to be managed with the intent of meeting flow objectives both seasonally and weekly. The volume of water available in any given year reflects both natural precipitation and the management of water held in storage. NMFS encourages the Action Agencies to secure the volumes of water needed from storage to increase the frequency of meeting the objectives and discourages actions that would decrease the likelihood of achieving the objectives. Since the achievement of flow objectives is highly influenced by natural precipitation and runoff, flow objectives cannot be hard constraints. Instead, they often serve as guides for the use of water on a seasonal or weekly basis.

9.6.1.2.3 FCRPS Reservoir Operations to Support Mainstem Objectives

Action 18: The Action Agencies shall operate the FCRPS during the fall and winter months in a manner that achieves refill to April 10 flood control elevations, while meeting project and system minimum flow and flood control constraints before April 10. During the spring, the Action Agencies shall operate the FCRPS to meet the flow objectives and refill the storage reservoirs (Albeni Falls, Dworshak, Grand Coulee, Hungry Horse, and Libby) by approximately June 30.

If both these objectives cannot be achieved, the Technical Management Team will make an in-season decision, weighing considerations unique to each particular year. Because research results indicate that flow augmentation has more direct survival benefits for summer than spring migrants, modest reductions in spring flows to facilitate reservoir refill would generally be preferable to refill failure.

Operating the storage reservoirs to their upper (flood control) rule curve by April 10 will provide a more natural hydrograph and will increase the likelihood that spring flow objectives will be met and reservoirs refilled by June 30. Having reservoirs full on or about June 30, when natural runoff declines, results in the greatest amount of water available for the summer migration period. NMFS recognizes that meeting these flow objectives while refilling reservoirs may not be possible every year, particularly in low water years.

Interruptions or adjustments in water management actions may occur due to unforeseeable power system, flood control, or other emergencies. Such emergency actions should be viewed by the Action Agencies as a last resort and should not be used in place of the long-term investments necessary to allow full, uninterrupted implementation of the required reservoir operations while maintaining other project purposes, such as an adequate and reliable power system.

During winter power system emergencies, water being held in reservoirs for spring and summer flow augmentation may be drafted. Once the emergency is resolved, any flow augmentation water that was used should be replaced as soon as possible, to the maximum extent. During summer emergencies, storage reservoirs may be drafted below biological opinion draft limits, or bypass spill for fish may be reduced.

Discussion of emergencies with effects of exceptional magnitude or duration should include involvement of regional executives. Section 9.4.2.2 provides for the development of more specific process modifications to address these needs in the water management plans.

Action 19: The Action Agencies shall operate specific FCRPS projects as follows:

Hungry Horse Dam. The Action Agencies shall implement VARQ (Corps 1999d) as a flood control operational strategy by January 1, 2001, and upon completion of coordination with appropriate Canadian entities. Under the 1995 NMFS Biological Opinion, the Action Agencies limited fall and winter reservoir drafts to try to achieve a 75% probability of being at the flood control rule curve elevation by April 10 of each year. NMFS acknowledges the chances of achieving a 75% probability of refill to April 10 flood control elevation will be reduced with implementation of VARQ and higher minimum flows for bull trout. Based on hydrosystem modeling results, the probability is approximately 60% of being at the flood control rule curve elevation by April 10 of each year.

Hungry Horse Reservoir may refill later than the June 30 objective, e.g., early July, if necessary to avoid spill that would exceed the state water quality standard for TDG. BOR shall develop a powerhouse maintenance plan to provide full powerhouse capacity to ensure that the project refills in a timely manner without spill that causes TDG to exceed the state water quality standard.

As called for in the USFWS 2000 Biological Opinion, the Hungry Horse minimum outflow shall be determined monthly based on the official volume inflow forecast for Hungry Horse Reservoir for the April through August period as follows. When the April through August runoff forecast is greater than 1,790 kaf, the minimum flow shall be 900 cfs. When the forecast is less that 1,190 kaf, the minimum flow may be reduced to 400 cfs. When the monthly forecast is between 1,190 and 1,790 kaf, the minimum flow shall be determined by linear interpolation between 400 and 900 cfs. The minimum flow in the South Fork Flathead River can be lowered to the physical limit of 145 cfs when the river reaches flood stage at Columbia Falls (13 feet msl).

The minimum flow requirement of 3,500 cfs at Columbia Falls shall be adjusted similarly to between 3,200 and 3,500 cfs based on monthly runoff forecasts. Specifically, when the April through August runoff forecast for Hungry Horse is greater than 1,790 kaf, the minimum flow shall be 3,500 cfs. When the forecast is less that 1,190 kaf, the minimum flow may be reduced to 3,200 cfs. When the monthly forecast is between 1,190 and 1,790 kaf, the minimum flow shall be determined by linear interpolation between 3,200 and 3,500 cfs. These adjustments in minimum flows are necessary to balance the benefits of flow protection for bull trout in the South Fork Flathead River below the dam with reservoir refill and associated biological benefits in the Flathead and Columbia River systems.

The Action Agencies shall limit the reservoir draft to elevation 3,540 feet by August 31 for salmon flow augmentation. BOR shall coordinate drafts for salmon with NMFS, USFWS, the Action Agencies, and other entities through the in-season management process. As a guideline for salmon flow augmentation releases during July and August, Hungry Horse may be operated in a manner that reduces impacts to other listed species while also releasing water to meet salmon flow objectives. Reduction in a second flow peak operation may be achieved by discharging water earlier, or at a more constant rate, to provide the full volume available for salmon.

Libby Dam. The Action Agencies shall implement VARQ (Corps 1999d) as a flood control operations strategy by October 1, 2001, and upon completion of coordination with appropriate Canadian entities. The 1995 NMFS Biological Opinion required the Action Agencies to limit fall and winter reservoir drafts to achieve a 75% probability of being at the flood control rule curve elevation by April 10. NMFS acknowledges that the chances of achieving a 75% probability of refill to April 10 flood control elevation will be reduced with implementation of VARQ and minimum flows for bull trout. Based on hydrosystem modeling results, the probability is approximately 40% of being at the flood control rule curve elevation by April 10 of each year.

Libby may refill later than the June 30 objective, e.g., early July, if necessary to avoid spill that would exceed the state water quality standard for TDG. The Action Agencies shall limit the reservoir draft to elevation 2,439 feet by August 31 for salmon flow augmentation. The Corps shall coordinate drafts for salmon with NMFS, USFWS, the Action Agencies, and other entities through the in-season management process. If Libby is below elevation 2,439 feet on July 1, the Action Agencies shall provide the USFWS bull trout minimum flow or inflow during the July and August salmon flow season. If this operation results in Libby storing above elevation 2,439 feet in July or August, that storage may be used for salmon flow augmentation before August 31.

As a guideline for salmon flow augmentation releases during July and August, Libby may be operated in a manner that reduces impacts to other listed species, while releasing water to meet salmon flow objectives. Reduction in a second peak operation can be achieved by implementation of a Canadian storage/Libby exchange of water or by releasing water earlier. However, operational flexibility should be retained to release water during the salmon flow season when fish timing or achievement of flow objectives warrant. This operation shall be consistent with winter/spring flood control needs and remaining on minimum or flood control flow during January through April.

<u>Albeni Falls Dam</u>. The action agencies shall continue the lake draw-up, kokanee egg-to-fry survival study at Lake Pend Oreille for the next 6 years. The evaluation shall begin in 2001 by drafting the lake to a fall/winter water level of elevation 2,051 feet. This operation is intended to allow winter storms to improve spawning gravel for kokanee along the shore of Lake Pend Oreille. During the fall/winter of 2002, the Corps shall maintain Lake Pend Oreille at elevation 2,055 feet until fry emerge from shoreline gravels.

By September 2003, USFWS shall secure independent scientific review involving the appropriate frequency of the lake draw up operation, i.e., from 1 to 3 years of draw up. Based on the findings of the independent scientific review of this evaluation, USFWS and NMFS shall provide written recommendations to the Action Agencies concerning fall/winter operations for the 2003 through 2006 period. During this 6-year evaluation period, the Action Agencies shall evaluate the effects of draw-up operations on all life stages of kokanee in Lake Pend Oreille and on predator-prey dynamics.

If, in September 2007, it is determined that lake level management above elevation 2,051 feet effectively improves kokanee production as bull trout forage, USFWS shall provide written recommendations on the frequency of Lake Pend Oreille draw-up for the remainder of this biological opinion.

<u>Grand Coulee Dam</u>. The Action Agencies shall implement VARQ as part of the system flood control operation as noted above at Hungry Horse and Libby. The Action Agencies shall limit fall and winter reservoir drafts to achieve an 85% probability of being at the flood control rule curve elevation by April 10. Grand Coulee may refill by July 4 if flow augmentation to meet flow objectives is not needed until after July 4. The Action Agencies shall draft the reservoir as needed to meet the summer flow objective at McNary Dam. Based on the July final April-to-August runoff volume forecast at The Dalles Dam, the Action Agencies shall limit the reservoir draft to the following end-of-August elevations: 1,280 feet in years when the forecast for The Dalles equals or exceeds 92 Maf and 1,278 feet in years when the forecast is less than 92 Maf.

Dworshak Dam. The Action Agencies shall attempt to refill the reservoir by June 30, while coordinating with the Technical Management Team to meet the spring flow objectives. The Action Agencies shall limit reservoir drafts to elevation 1,520 feet by August 31 to benefit the summer juvenile fish migration. The Action Agencies shall manage Dworshak discharge to attempt to maintain water temperatures at the Lower Granite Reservoir forebay dissolved gas monitoring station at or below 68°F (20°C). To facilitate refill and storage for next year's salmon operations, the Action Agencies shall discharge the established minimum one-turbine flow (about 1,500 cfs at present) following fisheries operations, unless higher flows are required for flood control purposes.

The Nez Perce Tribe expressed a concern that releasing cold water from Dworshak could inhibit the growth rate of wild fall chinook salmon in the Clearwater River. NMFS has attempted to manage the risks to these fish in recent years in its recommended summer flow and temperature operations at Dworshak Dam.

Action 20: The Corps shall operate the lower Snake River reservoirs within 1 foot of MOP from approximately April 3 until small numbers of juvenile migrants are present and shall operate the John Day pool within a 1½-foot range of the minimum level that provides irrigation pumping from April 10 to September 30.

The date for implementing MOP conditions may be delayed at the request of the Technical Management Team to facilitate drafting the pools to MOP to increase discharge at Snake River projects when such increased flows would be more beneficial to juvenile fish. Lower pools reduce the cross-sectional area, increasing water velocity at a given flow. Because juvenile migrants travel faster with increased water velocities, drawdown to MOP is expected to provide faster emigration and improved survival (NMFS 2000h).

Filling the lower three pools enables adult fishways to operate closer to the gate depth criteria of 8 feet at Lower Monumental Dam, 6 to 7 feet at Little Goose Dam, and 7 to 8 feet at Lower Granite Dam. However, recent information indicates that adult salmon pass the Snake River projects readily with gate depths lower than 7 feet (5.5 to 7 feet; low flows and low turbidity generally provide decreased passage times for adult migrants) (Blankenship and Mendel 1997, Bjornn et al. 1998). The effect of this operation will be evaluated during 2000 by the ongoing 2000 radio tracking study. A recommendation for refill of the lower three pools will be developed and included in the annual planning. This will include consideration of study results associated with fish passage. Lower Granite Dam should not be refilled until enough natural cooling has occurred in the fall, generally after October 1.

Action 21: The Corps shall routinely identify opportunities to shift system flood control evacuation volumes from Brownlee and Dworshak reservoirs to Lake Roosevelt and identify such opportunities for the Technical Management Team. The Corps shall implement flood control shifts as necessary to best protect listed fish, as called for by NMFS in coordination with the Technical Management Team, taking into account water quality issues and the concerns of all interested parties.

Flood control shifts afford an opportunity to increase the frequency of meeting Snake River spring flow objectives while only slightly affecting mid-Columbia River flow conditions. Lesser flood control drafts would occur at Brownlee and Dworshak through March, affording an opportunity to increase flows in the Snake River during April.

Action 22: The Corps and BOR shall implement VARQ flood control operations, as defined by the Corps (1999d), at Libby by October 1, 2001, and at Hungry Horse by January 1, 2001. By February 1, 2001, the Corps shall develop a schedule to complete all disclosures, NEPA compliance, and Canadian coordination necessary to implement VARQ flood control at Libby.

VARQ reduces system flood control drafts at Libby and Hungry Horse reservoirs in years when flood control risks are moderate (average to below-average water years) and adds about 10,000 cfs to summer flows at McNary Dam without increasing flood risks. Impacts to power, flood control, and environmental conditions in Canada have not been fully identified and coordinated. The VARQ concept is a change in system flood control developed by the Corps (1991, 1995, 1997, and 1999d) in response to NWPPC's 1984 Fish and Wildlife Program (NWPPC 1984), the 1995 FCRPS Biological Opinion, and requirements for Kootenai River sturgeon and bull trout imposed by USFWS (1995, 2000a). Conformance with these biological opinions resulted in discharges from Libby Dam during the annual reservoir refill period that far exceeded those envisioned in existing flood control operating plans. These fishery operations can reduce the likelihood and frequency of refill, adversely affecting the availability of augmentation water. NMFS' 1995 Biological Opinion also required the Corps to carefully evaluate system flood control operations. The VARQ concept responds to all these biological opinion requirements.

Hungry Horse can be operated to store up to 400 kaf more water in the spring, and Libby can store up to 1.5 Maf more under VARQ than under current constraints. Local flood control and other effects are small. These operations will increase flow levels in the lower Columbia River and the frequency of achieving the flow objectives by improving conditions for migration.

Whereas many interested parties are aware of this potential operation, implementing VARQ flood control will require additional coordination with Canada, as well as environmental compliance.

Several states did not support the adoption of VARQ during fall spawning periods as a flood control measure due to concerns that it would decrease flows below Bonneville Dam. NMFS' assessment is that VARQ will have a negligible effect on the provision of spawning flows below Bonneville. The draft limit for the Libby Reservoir's end-of-December elevation does not change under VARQ. The end-of-December draft limit for Hungry Horse does change, but operation of this reservoir in the fall is typically driven by meeting Columbia Falls minimum flows, which usually results in lower elevations than December flood control.

9.6.1.2.4 BOR Non-FCRPS Project Operations to Support Mainstem Flow Objectives

Action 23: BOR shall operate Banks Lake at an elevation 5 feet from full during August by reducing the volume of water pumped from Lake Roosevelt into Banks Lake by about 130 kaf during this time.

Banks Lake is a 27-mile-long equalizing reservoir for the Grand Coulee pump-generating plant. It also provides water to irrigate 672,000 acres of Columbia Basin Project lands. Banks Lake has an active storage capacity of 715,000 acre-feet. BOR indicates that the 130-kaf volume contained in the top 5 feet of Banks Lake storage (i.e., within its normal operating range) could be used to augment Columbia River flows during the summer migration period. This would be accomplished by reducing the volume of water pumped into Banks Lake from Lake Roosevelt and drafting it directly from Lake Roosevelt.

9.6.1.2.5 Non-Federal Project Operations Coordinated with FCRPS and BOR Projects to Support Mainstem Flow Objectives

Action 24: BPA and the Corps shall continue to request and negotiate agreements to annually provide 1 Maf of Treaty storage from January through April 15, release the water during the migration season, and seek additional storage amounts.

Action 25: BPA and the Corps shall continue to request, and negotiate with BC Hydro for storage of water in non-Treaty storage space during the spring for subsequent release in July and August for flow enhancement, as long as operations forecasts indicate that water stored in the spring can be released in July and August.

Flow objectives are met infrequently during the summer months in the lower Columbia River. Storing water during the spring runoff for release during the summer months increases the frequency of meeting the summer flow objectives.

Action 26: BPA and the Corps shall continue to evaluate, request, and negotiate with BC Hydro the shaping and release of water behind Canadian Treaty storage projects in addition to the non-Treaty storage water previously discussed during July and August.

This action may result in examination of various operational or configuration options for achieving this objective. Although not the only option, one long-term possibility for achieving this objective is installation of additional turbines in the powerhouses at Mica and Revelstoke dams. Once the side effects of these installations are addressed, flows could be shifted from other time periods and be increased by up to 20 kcfs during the months of July and August without the need to spill from these projects.

Several states and Tribes believed the installation of turbines in Canadian projects should be a requirement in the biological opinion. These projects are operated by Canadian entities that are not subject to this biological opinion. Canada's acceptance of this proposal will require the Canadian government to address local issues that will impact the outcome of the turbine discussions.

9.6.1.2.6 Measures to Evaluate and Adjust the Amount of Water Available to Support Flow Objectives

BOR Projects Basinwide. BOR projects operating in the Columbia River basin contribute to streamflow depletions in the Columbia River during the juvenile salmon outmigration season. These depletions decrease the frequency of achieving flow objectives needed to protect migrating juveniles. The following measures specify actions within BOR's authority to reduce streamflow depletions at its projects.

Action 27: Before entering into any agreement to commit currently uncontracted water or storage space in any of its reservoirs covered by this biological opinion to any other use than salmon flow augmentation, BOR shall consult with NMFS under ESA Section 7(a)(2). Such consultations shall identify the amount of discretionary storage or water being sought, the current probability of such storage or water being available for salmon flow augmentation, and any plan to replace the storage volume currently available to salmon flow augmentation that would be lost as a result of the proposed commitment. Also, BOR shall consult with NMFS before entering into any new contract or contract amendment to increase the authorized acreage served by any irrigation district receiving BOR-supplied water. NMFS' criterion in conducting such reviews is to ensure that there be zero net impact from any such BOR commitment on the ability to meet the seasonal flow objectives established in this biological opinion. Replacement supplies should have at least an equal probability of being available for salmon flow augmentation as the storage space or water that is being committed.

Given that current rates of water deliveries adversely affect survival conditions in the migration corridor, further depletions should be avoided until recovery is achieved.

Action 28: BOR shall pursue water conservation improvements at its projects and shall use all mechanisms available to it under state and Federal law to ensure that a reasonable portion of any water conserved will benefit listed species.

This action item is aimed at developing cooperative mechanisms to put more water in the mainstem Columbia River during the juvenile salmon migration season (April through August).

Water conservation is one mechanism that can reduce total diversions and consumption without adversely affecting agricultural production. To be valuable to listed fish, water conservation must result in increased stream flow. Accomplishing this task will require the cooperation of water users and the exploration of opportunities under state law to protect such water from diminution.

Action 29: Within 2 years from the date this opinion is signed, BOR shall provide NMFS with a detailed progress report addressing possible instances where BOR-supplied water within the Columbia River basin is being used without apparent BOR authorization to irrigate lands. In the report, BOR shall indicate how it shall proceed to identify and address instances of unauthorized use.

Federal agencies are required to consult only on actions that are "authorized, funded, or carried out by such agency[.]" 16 U.S.C. Section 1536(a)(2). NMFS recognizes that unauthorized uses of BOR-supplied water are by definition not "authorized, funded, or carried out" by BOR. As BOR works within the limits of its authority to address any identified episode of unauthorized use of BOR-supplied water, NMFS recognizes that, in some instances, BOR will have to take contract actions and consult on them. Accordingly, in action item 27 above, NMFS set out how those consultations will proceed. This reporting requirement will help all parties understand the nature and extent of actual unauthorized use.

Action 30: For those BOR projects located in the Columbia River and its tributaries downstream from Chief Joseph Dam (Table 9.6-2), BOR shall, as appropriate, work with NMFS in a timely manner to complete supplemental, project-specific consultations. These supplemental consultations shall address effects on tributary habitat and tributary water quality, as well as direct effects on salmon survival (e.g., impingement, entrainment in diversions, false attraction to return flows, and others). These supplemental consultations shall address effects on mainstem flows only to the extent to which they reveal additional effects on the in-stream flow regime not considered in this biological opinion (e.g., flood control).

This biological opinion considered the likely effects of BOR's Columbia River basin irrigation projects on flow conditions in the mainstem Columbia River migration corridor. Other effects, such as tributary habitat, fish passage and entrainment, and water quality, have not been evaluated in this biological opinion. To further the intensive approach defined in this RPA, timely consideration of such effects and, if necessary, development and implementation of measures to avoid, minimize, or mitigate them are needed. Supplemental consultations for several of these projects are currently underway (e.g., the Yakima Project and Umatilla). These overarching needs are further defined in the project-specific measures identified in Table 9.6-2.

<u>Columbia Basin Project</u>. Grand Coulee Dam, which is an integral component of the Columbia Basin Project, is also one of the specific FCRPS projects addressed in Section 9.6.1.2.3. Because the Columbia Basin Project diverts water from and returns it to the mainstem Columbia River

above McNary Dam, its storage and diversion operations are not easily separated from the other operations at Grand Coulee.

Table 9.6-2. BOR projects in the Columbia River basin subject to supplemental consultations.

Project	Location	Subbasin or Stream
Upper Columbia River (Upstream of Snake River Confluence)		
Chief Joseph[1]	North-central Washington, from Canadian border to Wenatchee	Okanogan and Columbia rivers
Okanogan	North-central Washington, near Okanogan	Okanogan River
Yakima	Central Washington, near Yakima	Yakima River
Lower Columbia (Downstream of the Snake River Confluence)		
Umatilla	Northeast Oregon	Umatilla and Columbia rivers
Crescent Lake	Central Oregon west of Bend	Deschutes River
Crooked River	Central Oregon, north of Bend	Crooked River
Deschutes	Central Oregon, north of Bend	Deschutes River
Wapinitia	North-central Oregon, south of The Dalles	Deschutes River
The Dalles[1]	North-central Oregon, near The Dalles	Columbia River
Tualatin	Northwest Oregon, west of Portland	Tualatin River (Willamette River)

[1] This table identifies irrigation works BOR owns and operates. The Corps owns and operates Chief Joseph Dam and its powerhouse and The Dalles Dam and its powerhouse.

Action 31: BOR shall assess the likely environmental effects of operating Banks Lake up to 10 feet down from full pool during August. The assessment and NEPA compliance work shall be completed by June 2002 to determine future operations at this project by the summer of 2002.

An additional 130 kaf could be obtained from Banks Lake storage if the project is not filled 5 more feet using Grand Coulee storage, resulting in a total draft of 10 feet from full pool, during the summer. This would provide a total flow augmentation volume of about 260 kaf from Banks Lake. Because this total draft is beyond the normal project operating range, however, BOR will have to conduct a formal study and NEPA compliance review on this action before implementation.

<u>BOR Upper Snake Projects and IPC Hells Canyon Complex</u>

Action 32: The Action Agencies shall acquire water for instream use from BOR's Upper Snake River basin projects and Idaho Power Company's Hells Canyon Complex during the spring and summer flow augmentation periods to improve the likelihood of achieving spring and summer flow objectives at Lower Granite Dam.

Ongoing Section 7 consultations with BOR on the Upper Snake projects and with FERC and the Idaho Power Company on the Hells Canyon Complex will consider the need for releases of water or other operations at these projects to address their effects on listed Snake River salmon and steelhead. Upon completion of these consultations and related biological opinions, and to the extent additional water or operating flexibility is available, the Action Agencies will pursue acquisition of such additional water from willing sellers or operating flexibility as offsite mitigation for the effects of the FCRPS projects. Such additional water or operating flexibility would be used to improve the ability to achieve the Snake River flow objectives identified in Table 9.6-1.

Dworshak Hatchery and Reservoir Operations

Action 33: The Corps, in coordination with USFWS, shall design and implement appropriate repairs and modifications to provide water supply temperatures for the Dworshak National Fish Hatchery that are conducive to fish health and growth, while allowing variable discharges of cold water from Dworshak Reservoir to mitigate adverse temperature effects on salmon downstream in the lower Snake River.

The rationale for providing improvements to the hatchery water supply is to isolate the effect of Dworshak Reservoir operations on Snake River temperature control from the effect of hatchery operations. At present, Dworshak Reservoir cannot be operated for optimal temperature releases because of adverse effects on hatchery rearing performance. This problem would be resolved by making improvements in the hatchery water supply system to accommodate releases of cooler water from Dworshak to benefit salmonid migrants and water quality in the lower Snake River.

Action 34: The Action Agencies shall evaluate potential benefits to adult Snake River steelhead and fall chinook salmon passage by drafting Dworshak Reservoir to elevation 1,500 feet in September. An evaluation of the temperature effects and adult migration behavior should accompany a draft of Dworshak Reservoir substantially below elevation 1,520 feet.

The rationale for evaluating an additional 20-foot draft of Dworshak Reservoir in September is to determine whether cooling Snake River temperatures during September would provide an adult passage benefit. The potential benefits are 1) reduction in water temperature, 2) possible elimination of a thermal block that delays adult migration into and through the lower Snake River, and 3) improved gamete viability. An evaluation should be conducted to assess the effects of the September draft on lower Snake River temperatures and on the migratory behavior and passage timing of adult salmonids that are equipped with depth and temperature-sensitive tags. An evaluation of Dworshak refill probability indicates that this study operation would have little impact on reservoir refill by the end of June in the following year, i.e., two additional refill misses in BPA's 50-year hydrosystem study.

Flood Control Assessment

Action 35: The Corps shall develop and conduct a detailed feasibility analysis of modifying current system flood control operations to benefit the Columbia River ecosystem, including salmon. The Corps shall consult with all interested state, Federal, Tribal, and Canadian agencies in developing its analysis. Within 6 months after receiving funding, the Corps shall provide a feasibility analysis study plan for review to NMFS and all interested agencies, including a peer-review panel (at least three independent reviewers, acceptable to NMFS, with expertise in water management, flood control, or Columbia River basin anadromous salmonids). A final study plan shall be provided to NMFS and all interested agencies 4 months after submitting the draft plan for review. The Corps shall provide a draft feasibility analysis to all interested agencies, NMFS, and the peer-review panel by September 2005.

The primary objectives of this feasibility analysis will include reducing the effects of flood control operations on the spring freshet, particularly during average to below-average runoff years; minimizing flow fluctuations during fall chinook emergence and rearing; and achieving a high probability of reservoir refill, particularly at Dworshak, Grand Coulee, Hungry Horse, and Libby reservoirs, while maintaining acceptable levels of protection for developed areas within the active floodplain. This analysis will consider all aspects of flood control, including the flood control target flow(s), associated storage reservation diagrams, the method of calculating the initial control flow, and the timing and coordination of flood control management. The study will incorporate the best currently available forecast technology for estimating runoff and peak flows. Innovative concepts, such as using an expert system to define operations in real time, that would increase system flexibility or the ability to achieve the above stated objectives should be incorporated to the extent practical. New storage reservation diagrams should include mechanisms for interpolation to facilitate higher storage contents going into the spring in some years. The Corps will also identify those improvements necessary to facilitate higher flood control target flows and estimate the cost and time needed to implement such improvements.

This analysis will include all Federal, non-Federal, and Canadian projects currently operated for system flood control. Because modifying flood control operations would affect an array of interests, the Corps should consult with all interested state, Federal, Tribal, and Canadian agencies in developing its analysis. The final feasibility report will include a proposed action and respond to all concerns and comments on the draft.

System flood control strongly influences streamflow characteristics in the mainstem Snake and Columbia rivers. As described in Section 6 of this biological opinion, these hydrologic effects affect juvenile salmon survival. While current flood control operations routinely reduce even non-damaging floods, peak flows of historical magnitude (e.g., the 1948 Vanport flood) would result in substantial damage. The intent of this study is to refine flood control operations such that they cause the least possible reduction in runoff volumes and the probability of reservoir refill while maintaining high levels of protection from damaging floods. Preliminary analysis of modifying system flood control showed that potentially much higher spring flows were possible (Corps 1997) in some years.

Much of the existing flood control operation plan dates to the 1960s, and a systematic review of flood control operations has not occurred since 1991. That study, however, was based on the fundamental premise *"that the existing flood control capability ...would remain unchanged after any rule curve modifications were made* (Corps 1991)." Thus, *"...it is conceivable that flood control criteria could be reduced substantially, and levees raised a corresponding amount to compensate."* A broader consideration of flood control options could identify operations that would benefit the fishery without increasing the likelihood of damaging floods.

New streamflow prediction techniques, including extended streamflow prediction (ESP) (NOAA River Forecast Center streamflow model) and remote sensing, have greatly improved since 1969. Computer improvements facilitate consideration of a broader range of alternatives and the ability to manage flood risks more closely to a real-time basis. A thorough investigation of new forecasting technologies would enhance system response and afford greater precision in system flood control operations.

Furthermore, flood control concepts are changing. Historically, efforts were made to protect all developed lands from flooding by using levees, revetments, and upstream storage. These efforts have effectively disconnected rivers from their floodplains and have had both ecological and human consequences (Benner and Sedell 1997). Ecologically, diverse and integral habitats are lost when structures isolate a river from its floodplain (Ligon et al. 1995, Corps 2000b). Riparian corridor simplification is a significant cause of salmon declines (Ligon et al. 1995, Corps 2000b). Also, by cutting off upstream floodplains from the river, vast flood storage potential is lost, and floodplain development is encouraged. Thus, when large floods occur, the outcomes in terms of property damage can be more severe than would have occurred if lesser flood protection efforts had been taken and floodplain development discouraged. By examining flood damage areas and flood protection structures throughout the river corridor, the Corps may identify opportunities to bring more connectivity to some areas of active floodplain (e.g., undeveloped land and farmland) and more effective flood protection to others (e.g., communities).

Libby Operations

Action 36: By October 1, 2002, the Corps shall develop and, if feasible, implement a revised storage reservation diagram for Libby Reservoir that replaces the existing fall draft to a fixed end-of-December elevation. One option is to evaluate variable drafts based on the El Niño Southern Oscillation Index (SOI) predictions or other forecast methodologies of runoff volume. To implement this change, the Corps shall complete successful coordination with Canada under the Columbia River Treaty.

Currently, a fall draft at this project is aimed at reaching a fixed end-of-December elevation to ensure that, given other project constraints, enough water can be evacuated to achieve desired levels by the end of April in all years. If lesser drafts were made, it could be difficult to achieve desired reservoir levels in the wetter years. Traditional snow-water surveys are not available until January, so Libby is drafted each year in the fall, assuming a wet-year condition. In low water years, this can result in drafts below the subsequent April 30 upper rule curve elevation (end of storage evacuation season) and result in the project being unable to refill by the end of June. Under current operating criteria, hydrosystem regulation studies (BPA 2000b) show that Lake Koocanusa does not achieve the 75% probability of refill proposed by the Corps in the biological assessment (BPA et al. 1999). These excessive drafts can increase the streamflow attenuation needed to achieve refill in the spring and reduce the probability of refill, placing additional risks on listed fish, particularly in the driest years when increasing discharge would be most valuable.

Recent advances in climatology have resulted in predictive tools that roughly estimate Pacific Northwest runoff volumes from meteorological conditions in the southern Pacific. The Corps has adopted an SOI-based runoff model as the best available forecast for Dworshak that uses this forecast to define Dworshak drafts from January through April. The Corps is investigating the use of a similar runoff model for Libby Dam. The Corps is also investigating operational changes that could alleviate the reason for avoiding all spills at Libby Dam, which is a contributing factor in the current fixed end-of-December reservoir draft. This action would expand the use of a SOI-based or a similar runoff prediction method into the fall at Libby Dam and could result in revision of the storage reservation diagram to allow reduced drafts in average-to-dry years.

9.6.1.2.7 Actions to Address Columbia Basin Project Effects Other than Flow Depletions and Storage Operations. Certain facilities and operations at the Columbia Basin Project present risks to listed salmon and steelhead other than those associated with mainstem flows. BOR will investigate the effects of these facilities and operations. Where adverse effects on listed salmon or steelhead are found, BOR will develop measures to avoid or minimize such effects in consultation with NMFS.

Action 37: BOR shall investigate the attraction of listed salmon and steelhead into wasteways and natural streams receiving waste water from the Columbia Basin Project. If listed fish are found to be attracted into these channels, BOR shall work with NMFS to identify and implement structural or operational measures to avoid or minimize such use, as warranted.

Action 38: By March 1, 2002, BOR shall install screens meeting NMFS' screen criteria at the canal intakes to the Burbank No. 2 and Burbank No. 3 pump plants. BOR shall connect the Burbank No. 3 intake canal to Burbank Slough to provide juvenile fish egress. BOR shall coordinate with NMFS on each of the actions identified above.

Action 39: BOR shall evaluate the water quality characteristics of each point of surface return flows from the Columbia Basin Project to the Columbia River and estimate the effects these return flows may have on listed fish in the Columbia River and in the wasteways accessible to listed fish. By June 1, 2001, BOR shall provide NMFS with a detailed water quality monitoring plan, including a list of water quality parameters to be evaluated. If the water quality sampling reveals enough water quality degradation to adversely affect listed fish, BOR shall develop and initiate implementation of a wasteway water quality remediation plan within 12 months of the completion of the monitoring program.

Return flows from BOR's Columbia Basin Project may reduce water quality in the Columbia River and may adversely affect aquatic life and listed salmon. Because of the potential for adverse effects on listed fish, detailed water quality monitoring and analysis are needed to define these water quality effects. Depending on the results of the water quality sampling, BOR should develop and begin implementation of a water quality remediation plan for BOR wasteways within 12 months of completing the water quality monitoring program and include the plan as part of the Action Agencies' annual and 5-year water quality improvement plans. This measure is intended to supplement the MOU between BOR, EPA, the Washington Department of Ecology, and the three Columbia Basin irrigation districts regarding surface water quality protection of the Federal Columbia Basin Project waters. Remediation measures will be consistent with the terms of that agreement to the extent possible.

9.6.1.3 Juvenile Fish Transportation

9.6.1.3.1 Strategy. This RPA requires transportation of juvenile salmon and steelhead migrants in spring and summer. During the spring migration, transport is required at Lower Granite, Little Goose, and Lower Monumental dams. During the summer migration, transport is required from the same three Snake River dams and is also required from McNary Dam. Spill is to be provided in accordance with Section 9.6.1.4.4 to provide the highest survival passage route for inriver migrants during the spring months and to provide for research in summer. Except as specifically provided for research, however, all collected fish are to be transported.

The spring transport strategy in this RPA requires both transport and spill at collector projects to spread the risk by ensuring favorable project passage conditions for inriver migrants. There is no attempt to manage to a specific transport/inriver ratio. Estimates of the proportion of SR spring/summer chinook that are expected to be transported under this strategy range from 43% to 91% depending on flow/runoff conditions.

The current strategy reflects a management program based on transportation research conducted to date. However, ongoing research using PIT tag technology will allow a much finer level of resolution to be obtained on the seasonal effects of transportation. The research results will be reviewed annually, and adaptive management changes may be made in the transportation strategy if definitive research results support a change in strategy.

The summer transport strategy is to maximize collection and transportation due to concerns about low inriver survival rates. During the summer, flow is frequently below the biological flow objectives established by NMFS, and water temperature is frequently above the water quality standards established by EPA and the state water quality agencies. As a result, fish spill is curtailed, and all collected fish are transported during the summer to improve overall juvenile fish survival.

The actions in this section are presented as follows:

- Current and near-term actions
- Studies, including research, monitoring, and evaluation
- Future actions

9.6.1.3.2 Current and Near-term Actions

Action 40: The Corps shall continue to transport all non-research juvenile salmonids collected at the Snake River collector projects. The Corps and BPA shall continue to implement voluntary spill at all three Snake River collector projects when seasonal average flows are projected to meet or exceed 85 kcfs.

If new information shows that survival through inriver migration, including returning fish to the river, is beneficial, these data will be reviewed and discussed during the annual planning process. In particular, BPA and the Corps, working with NMFS through the annual planning process, have to consider the scientific basis for the 85-kcfs voluntary spill trigger. Any resulting changes in the annual transport operations will be formalized through the consultation framework or a similar process.

Action 41: The Corps and BPA shall continue (pending results of the McNary Transport Evaluation) to bypass juvenile spring migrants collected at McNary Dam and shall provide the spring spill levels described for that project.

Transport of spring migrants from McNary was suspended in the 1995 FCRPS Biological Opinion (NMFS 1995a) because a review of the data indicated the benefit from transport was uncertain. This moratorium on spring transport from McNary was continued in the 1998 Supplemental FCRPS Biological Opinion (NMFS 1998) because the adult returns of detected PIT-tagged juvenile fish that passed through the McNary bypass system in 1994 were lower than expected. These data suggest there may be an undetected problem with the juvenile bypass system. This issue should be resolved before initiating the McNary spring transport evaluation.

Action 42: The Corps and BPA shall operate the collector projects to maximize collection and transportation during the summer migration (i.e., no voluntary spill except as NMFS deems necessary for approved research).

Past research evaluating fall chinook transport from McNary indicated the highest benefits occur during the summer low flow/warm water temperature periods. The 1982 research (Park et al. 1982) evaluated transport by truck during the early, middle, and late phases of the summer outmigration.

The early control group (June 25 to July 2) was released when daily average river flows were dropping from 444 to 372 kcfs, and water temperature averaged about 60°F (16°C). Based on survival to adulthood, transport yielded no benefit to the early phase (0.9:1).

The middle control group (July 6 to 22) was released when river flows ranged from 358 to 206 kcfs, and water temperatures ranged from 61° to 66°F (16 to 19°C). Based on survival data, there was a minor benefit to the middle phase (1.36:1).

The late control group (July 27 to Aug 5) was released when river flows were dropping from 218 kcfs to 158 kcfs, and water temperatures were 67° to 70°F (19 to 21°C). This group showed the highest transport benefit of 4.6:1. Available data, although limited, did not indicate a benefit from transport of summer migrants during early summer. A similar study was conducted in 1983 (Park et al. 1984), but marking did not begin until July 7 that year so the data were not comparable to the 1982 study. Results, however, showed a positive benefit from both barge and truck transport. Control groups in that study were released when river flows ranged from 169 to 232 kcfs.

Action 43: The Corps shall not initiate collection of subyearling fall chinook for transportation at McNary Dam until inriver migratory conditions are deteriorating (i.e., no longer spring-like).

In general, the switch from spring to summer operation will occur on or about June 20. Each year in the in-season management process, the Technical Management Team has the discretion to recommend a change in transportation operations at McNary Dam earlier or later based on in-season monitoring of inriver conditions. When more favorable spring-like flow and temperatures either end before or extend after the spill planning dates, the actual date to end spill at collector projects, and to initiate transport from McNary, will be modified, continuing to spread the risk of transportation versus inriver passage for spring migrants as long as spring-like river conditions persist.

Spring-like is defined as favorable flow and water temperature conditions; i.e., river flows are at or above the spring flow target (220 to 260 kcfs) at McNary Dam, and ambient water temperatures are below 62°F (17C°).

Action 44: The Corps shall extend the period of barge transportation from the lower Snake River dams and McNary to further reduce reliance on trucking.

Barge transport of spring migrants from the lower Snake River dams was extended approximately 3 weeks in 1998 to partially address regional concerns regarding truck transportation. The Corps has proposed to extend the barging period another 5 weeks (to around the end of July). NMFS views the proposed extension as a first step; however, a further extension is desired. NMFS recognizes that, as a result of prioritizing available O&M funds, a further extension of barging will have to be phased in over a period of years.

9.6.1.3.3 Studies (Including Research, Monitoring, and Evaluations)

Action 45: By the end of 2001, the Corps shall develop, in coordination with NMFS and the other Federal, state, and Tribal salmon managers, a McNary Dam transportation evaluation study plan specifically focusing on the response of UCR spring chinook and steelhead to transportation. Approved research should begin by 2002, if feasible.

Evaluation of spring transport from McNary shall be initiated in 2002, assuming that adult PIT-tag detectors will be installed at selected locations by spring 2002 and pending results of the McNary Dam juvenile fish bypass evaluation. Implementation of such research is a high priority and should serve to accelerate development and installation of adult PIT-tag detection capability in mainstem adult fishways. At a minimum, objectives of the study shall include the following:

- Identification of population and/or genetic composition of test fish
- The absolute return rates of transport and inriver groups
- The ratios of transport to inriver return rates and their relationships to river conditions
- The effects of transportation from McNary on homing
- Relationships between ratios of transport and inriver return rates and measurements of juvenile survival (D values) below McNary Dam

Action 46: The Corps and BPA, in coordination with NMFS through the annual planning process, shall evaluate transport to inriver return ratios for wild SR yearling chinook salmon and steelhead. In addition, the Corps and BPA shall also evaluate the effects of transportation on summer-migrating subyearling SR chinook salmon.

The research methodology currently used to evaluate spring-migrating fish is to mark and release wild fish at Lower Granite Dam and re-collect some of them for transport at Little Goose Dam. An inriver group of marked fish is allowed to continue their migration inriver. This study protocol was selected to handle the fewest wild salmon and to increase the undetected inriver sample group of fish. The existing study design should continue until wild Snake River anadromous salmonids are abundant enough to conduct studies by PIT-tagging wild fish in natal areas above the lower Snake River dams.

If the decision for the long-term operation of FCRPS projects on the lower Snake River includes continued reliance on transportation, the Corps and BPA will continue transport survival studies for spring and summer migrants passing Lower Granite Dam in future years. Information from these studies will be the basis for modifications to the transportation program to increase salmon survival. Future transportation studies will include the evaluation of modifications made to the transportation system.

NMFS has adopted a spread-the-risk policy for transportation of spring migrants while studies are being conducted to evaluate the effects of the spring transportation program. In contrast, NMFS has chosen to maximize transportation of fall migrants because of the adverse conditions that exist for inriver migrants during the summer season. Historic data have demonstrated a benefit to transportation. Additional research should occur to reassess the effectiveness of transportation under more recent conditions.

The evaluation of summer transport will consist of determining the smolt-to-adult survival of subyearling fall chinook transported from Lower Granite Dam relative to marked study fish left to migrate inriver. This study will require adequate numbers of representative test fish (i.e., Lyons Ferry hatchery stock) and suitable inriver conditions for comparison with transportation. This includes spill at Snake River collector projects to reduce turbine mortality, alternative water management strategies to enhance flows and reduce water temperature, and more intensive predator management. To reduce the risks associated with an incorrect assumption about the effectiveness of either transportation or inriver migration, spill to enhance inriver conditions will be included as a test condition on an alternating annual basis. In this way, outmigrants will be subject both to inriver conditions that include spill at Snake River dams and maximum transport conditions across the duration of this study. The ability to provide summer spill at Snake River dams will require modifications of the electrical transmission system. These upgrades are expected to be completed by 2004. Pending completion of these upgrades, the inclusion of spill would start and would continue for several years. This study will start under current operations beginning in the summer of 2001.

The development of the specific study protocol should be coordinated through the Regional Forum and research processes. The Action Agencies will include these studies in the annual and 5-year hydrosystem plans.

Action 47: During all transport evaluations, the Corps and BPA, in coordination with NMFS through the annual planning process, shall include an evaluation of delayed mortality (D) of transported versus inriver migrating juvenile anadromous salmonids.

Considerable uncertainty exists concerning the levels of differential post-Bonneville Dam mortality of transported and non-transported fish. Evaluations of post-transport and post-bypass delayed mortality are high priorities. The highest priority is determining how much transportation mitigates for the loss of juvenile anadromous salmonids during passage through the hydrosystem. The mechanism for implementing this action (mark and recapture studies) is described in Section 9.6.5.3.5.1.

Action 48: The Corps and BPA shall evaluate the effects of prior transport as smolts on the homing of adults.

Past research was not designed to directly evaluate the effects of transportation on the homing of returning adults. Ancillary data derived from earlier studies suggested that transportation-induced homing impairment was minimal. Studies designed to directly and precisely compare homing capabilities of transported and non-transported fish are needed. This research will require the installation of adult PIT-tag detectors at several dams and hatcheries on the Columbia and Snake rivers.

Action 49: The Corps shall evaluate strategies to enhance post-release survival of transported fish; examples of such strategies include timing releases so that fish arrival at the estuary corresponds to minimal interactions with predators and maximum availability of forage and locating releases so as to decrease passage time through areas of high predation.

No consideration has been given to the timing of fish arrival in the estuary when scheduling fish transport operations. In the past, the preference for release of transported fish was after dark to reduce the potential for predation, but this does not occur on a regular basis. Additional information on spring chinook transported from the Snake River indicates that fish released to arrive at the saltwater interface during the ebb tide move rapidly into the Columbia River plume. Fish that reach the saltwater interface during high tide hold in the estuary and either move upstream in the navigation channels or hold over in the shallow water grassflats. In both cases, salmon are exposed to increased levels of avian predation.

9.6.1.3.4 Future Actions

Action 50: BPA and the Corps shall install necessary adult PIT-tag detectors at appropriate FCRPS projects before the expected return of adult salmon from the 2001 juvenile outmigration.

By October 2000, the Action Agencies will develop a schedule for installing adult PIT-tag detectors at projects by working through the annual planning process and the Regional Forum. The schedule will maximize the ability to conduct research identified in this biological opinion in a timely manner and will address the possibility of installing detectors at Bonneville and McNary dams by 2002. Adult detector installation identified in the annual planning process should be put in place as soon as possible. If technical problems preclude installation of these adult PIT-tag detectors within this time frame, the evaluation of spring migrant transportation from McNary should be delayed until the detection systems are certain to be installed.

Action 51: If results of Snake River studies indicate that survival of juvenile salmon and steelhead collected and transported during any segment of the juvenile migration (i.e., before May 1) is no better than the survival of juvenile salmon that migrate inriver, the Corps and BPA, in coordination with NMFS through the annual planning process, shall identify and implement appropriate measures to optimize inriver passage at the collector dams during those periods.

Limited available data suggest that juveniles collected and transported early in the spring season do not survive as well as fish that are transported in May and thereafter. It may be that, because they are transported, those fish arrive in the estuary before they are physically prepared to enter saltwater, or alternatively, predator abundance may vary during the early ocean phase in different years. Additional data are needed to help reduce this uncertainty.

Action 52: The Corps shall identify and implement improvements to the transportation program.

Such improvements should include maintenance/upgrade of fish transport trailer chillers before the summer trucking season (as long as trucking continues) and daily transport of juvenile salmon exhibiting signs of *Columnaris* disease during the summer warm-water season, preferably in 5- to 10-ppt saline with minimal handling if transported by truck.

Action 53: The Corps shall evaluate and implement structural and operational alternatives to improve juvenile transportation at the collector dams.

These alternatives could include improvements to the juvenile bypass systems, holding and loading facilities, and construction of smaller barges for use during the summer.

9.6.1.4 Juvenile Fish Passage

The measures described in this section represent the best starting points for planning future capital investment in activities to improve the survival of juvenile salmon migrating past the Corps mainstem FCRPS dams. The specific list of measures to be implemented, their priority, and the method of evaluation will be developed in the 1- and 5-year plans described in Section 9.4. As determined through the annual planning process in Section 9.4, other combinations of measures may also be deemed sufficient to meet the juvenile and adult performance standards and, thus, to avoid jeopardy.

Based on information in the biological effects analysis in Appendix D, Bonneville, The Dalles, and Lower Monumental dams have the lowest juvenile fish passage survival rates in the FCRPS.

For this reason, improvements in juvenile dam passage survival at these mainstem dams should be an area of immediate focus.

Many of the measures described in this section are limited to prototype or facility development and evaluation and include statements that the Action Agencies are expected to implement an action based on study results as warranted. The intent in these cases is to proceed to implementation immediately upon completion of testing, unless the results present problems that have to be addressed through further testing before implementation. The fish passage survival analysis in Section 9.7 assumes that fish passage facility improvements would be implemented, not just tested. As a result, progress in moving from research and development to implementation will be a necessary and integral part of the annual planning and review process, and undue delay may require a reinitiation of consultation.

9.6.1.4.1 Juvenile Fish Passage Strategy. A primary objective of the biological opinion is to increase survival of juvenile outmigrants through the Federal hydrosystem. This objective should be accomplished consistent with two biological principles: 1) protecting biodiversity and 2) favoring fish passage solutions that best fit the natural behavior patterns and river processes (ISAB, 1999). This applies to fish passage through the eight FCRPS hydroelectric projects and their associated reservoirs. The purpose of this fish passage strategy statement is to provide general guidance on dam passage priorities for future annual implementation planning.

<u>Spillway Passage</u>. Spillway passage is the preferred passage method for juvenile salmonids that are not collected and transported. It should be the baseline against which other passage methods are measured. The body of research evidence indicates that juvenile survival is generally highest through this passage route and suggests it can reduce forebay delay. Therefore, measures that increase juvenile fish passage over FCRPS project spillways are the highest priority unless it can be shown that alternative passage improvements would provide comparable survival. This assumes that spillway passage is implemented in a biologically safe manner to maintain appropriate water quality, while ensuring adequate juvenile egress conditions in the tailrace and minimizing effects on adult passage.

<u>Surface Bypass Passage</u>. Surface bypass is defined as a surface-oriented route that provides an appreciable attraction flow-field and discharges juvenile fish directly to the project tailrace. Continued development and testing of surface bypass prototypes at mainstem FCRPS projects should be a high priority. A surface bypass at one or more spill bays, or through a surface bypass next to the spillway or powerhouse, may provide complementary survival benefits for fish that do not pass through a conventional spillway tainter gate. Surface bypass passage is a promising concept that may, with further testing and development, satisfy the intent of increasing safe passage through a high-flow conveyance similar to the spillway. It also has a potential benefit of providing fish passage with incrementally lower spill discharges and lower production of TDG.

<u>Surface Collection Passage</u>. In contrast to surface bypass, surface collection is defined as a surface-oriented route that entails collection at one or more entrances, followed by lateral routing

in a channel that guides fish away from turbine intakes. In this biological opinion, surface collectors are considered to be installed across a portion of, or over the entire upstream face of, the powerhouse at a given site. For fish that do not pass through either spillway or surface bypass routes, this option is expected to provide more natural passage conditions for those that approach the powerhouse. Similar to the surface bypass concept, surface collection is also a promising concept that may, with further testing and development, satisfy the intent of increasing safe passage through a high-flow conveyance. With successful development in the future (including reconciling concerns regarding high discharge outfalls), this option would be preferred to other powerhouse passage options (see below).

Powerhouse Intake Screen and Bypass Systems. Turbine intake screens and bypass systems provide the best protection for those fish that enter turbine intakes (as opposed to passing through other non-turbine routes). Increasing juvenile survival through collection and safe passage using this type of system continues to be a priority at many FCRPS hydro projects. This fish protection system will continue to be the primary powerhouse protection alternative at some projects until either surface bypass or surface collection is fully developed and constructed.

Turbine Passage. The least preferable route of passage for juvenile and adult fish is through turbines, where a generally higher mortality rate occurs due to direct mechanical injuries and adverse pressure changes incurred while passing through the turbine. Further, indirect mortality is likely a significant problem downstream of the powerhouse, where disoriented fish are vulnerable to predation. Efforts described above to reduce turbine passage notwithstanding, it is prudent to continue to research and, where appropriate, implement improved turbine designs that reduce direct and indirect mortality. Additional investigations are necessary to reduce the magnitude of direct and indirect turbine mortality, as well as continued evaluations of recent advances in turbine design such as minimum gap runners.

9.6.1.4.2 Overview of RPA Actions Project-by-Project. The following project-by-project overview is provided for ease of reference so that juvenile passage measures, which are detailed as actions in the following sections, can be viewed and understood from a broader context. This section also describes issues such as decision dates for alternative passage improvements and other considerations that may influence implementation.

Bonneville Dam. The dam passage survival rate at Bonneville Dam is currently one of the lowest of any Corps FCRPS project and is, therefore, the highest priority relative to the need for improvements. Existing spill levels, configurations, and facilities at Bonneville Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 24-hour spill; with nighttime spill limited to the TDG cap, and daytime spill limited to 75 kcfs for adult passage
- Standard-length screens at all 18 main units (at both powerhouses)

- A first powerhouse monitoring facility/bypass outfall that releases fish into the immediate tailrace and a new second powerhouse monitoring facility/bypass outfall that releases fish approximately 9,000 feet downstream of the powerhouse

- An ice and trash sluiceway at the first powerhouse

- An 18-bay spillway with deflectors on 13 bays

Bonneville First Powerhouse. The Corps will evaluate surface collector and extended submerged intake screen prototypes in 2000, followed by a decision to proceed with development of one alternative (or a hybrid of each); proceed to design and construction of the most promising option; complete minimum gap turbine runner installation and evaluation; continue to develop debris-control measures; and continue to develop improvements to the existing juvenile fish bypass system (including dewatering screens and outfall relocation).

Bonneville Spillway. The Corps will finish spillway deflector optimization development and implement deflector additions and improvements, develop optimum spill patterns and conduct juvenile survival studies, continue to evaluate adult spillway fallback and implement remedies as warranted, synthesize results to determine how to optimize spillway adult and juvenile project/spillway survival, and implement the most promising measures.

Bonneville Second Powerhouse. The Corps will develop and implement a surface bypass corner collector, pending high-flow outfall investigation results for increasing the high-flow impact velocity criterion, conduct outfall site selection evaluations, and design and construct a corner collector system by 2004 (if exceeding the velocity criterion does not increase juvenile mortality); continue intake screen guidance improvement investigations and implement them as warranted; implement auxiliary water improvement measures; investigate and implement debris control measures; investigate a less intrusive PIT-tag interrogation method for the new juvenile fish bypass system; and implement measures as warranted.

The Dalles Dam. Spill levels, configurations, and facilities at The Dalles Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 24-hour spill at 40% of river flow
- An ice and trash sluiceway operated as a surface bypass
- A 23-bay spillway, with a shallow spilling basin and no deflectors

The Corps will evaluate, identify, and implement the appropriate 24-hour spill levels (day and night considered separately) to optimize spring and summer juvenile survival; investigate surface bypass collection efficiency improvements (blocked trash racks) and sluiceway passage survival in 2001 and fully implement measures across the powerhouse as warranted; evaluate the juvenile survival benefit of sluiceway outfall relocation; and implement composite outfall relocation and auxiliary water emergency measures. If the spillway juvenile mortality rate is excessive at 40%

spill in 2000, the Corps will investigate mechanistic causes of physical injury, including potential construction of spillway deflectors. The Corps will defer an intake screen and bypass system implementation decision until other measures are fully evaluated and consider the installation of fish friendly turbine designs (e.g., minimum-gap turbine runners) as part of the turbine rehabilitation program.

John Day Dam. Spill levels, configurations, and facilities at John Day Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 12-hour spill from 6:00 p.m. to 6:00 a.m. (7:00 p.m. to 6:00 a.m., May 15th to July 31st), at 60% of the outflow up to the TDG gas cap

- Standard-length screens at all 16 main units

- A new juvenile fish monitoring facility that releases fish approximately 1,000 feet downstream of the powerhouse

- A 20-bay spillway, with new deflectors on 18 bays

The Corps will continue 24-hour spill investigations to determine juvenile passage and survival benefits; construct end deflectors by 2002 and assess water quality and fish survival benefits of deflector optimization; conduct surface bypass removable spillway weir prototype evaluation in 2002 as a surrogate for skeleton bay surface collection; continue to develop extended intake screen system; conduct prototype tests in 2001/2002; synthesize incremental juvenile survival benefits of all juvenile passage options in late 2002 and proceed with the most promising survival-improvement measures; and investigate less intrusive PIT-tag interrogation method for juvenile sampling facilities and implement them as warranted.

McNary Dam. Configurations and facilities at McNary Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 12-hour spill from 6:00 p.m. to 6:00 a.m. at the TDG cap

- Extended-length screens in all 14 main units

- Juvenile fish monitoring facility/collection and bypass, with the capability to either collect and transport fish via barge or truck, or release fish to the river

- A 22-bay spillway, with deflectors on 18 bays

The Corps will conduct spillway efficiency and effectiveness evaluations, spillway deflector optimization investigations, and surface bypass removable spillway weir prototype studies as appropriate (based on results at other locations); determine optimum spring migration juvenile survival configuration and operations; implement promising measures; upgrade extended intake screens and implement gatewell screen cleaning and other juvenile bypass system improvements; investigate and implement remedies to address adult egress from juvenile bypass system; investigate a less intrusive PIT-tag interrogation method for juvenile sampling facilities; implement it as warranted; and evaluate the need for juvenile bypass outfall relocation.

Ice Harbor Dam. Configurations and facilities at Ice Harbor Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 24-four hour spill (with nighttime spill limited to the TDG at the cap and daytime spill limited to 45 kcfs for adult passage)

- Standard-length screens at all six main units

- A 10-bay spillway, with deflectors on 10 bays

The Corps will investigate and implement remedies to address adult egress from the juvenile bypass system; assess the provision of a less intrusive PIT-tag interrogation method for the Ice Harbor juvenile bypass system; consider, based on other studies, a surface bypass removable spillway weir (RSW); and consider the installation of fish-friendly turbines as part of the turbine rehabilitation program.

Lower Monumental Dam. Configurations and facilities at Lower Monumental Dam related to juvenile fish passage include the following operating criteria identified in this biological opinion or the Fish Passage Plan:

- A 24-hour spill at the gas cap

- Standard-length screens at all six main units

- Juvenile fish monitoring facility/collection and bypass, with the capability to either collect and transport fish via barge or truck, or release them to the river

- An eight-bay spillway, with deflectors on six middle bays

The Corps will continue the 24-hour spill; investigate a surface bypass RSW, spillway deflector optimization (including the addition of-end bay deflectors), and juvenile bypass system separator replacement, as well as making other system improvements; investigate a new juvenile bypass outfall location; investigate an extended intake screen system; and implement the most promising measures to increase juvenile survival.

Little Goose Dam. Configurations and facilities at Little Goose Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 12-hour spill (6:00 p.m. to 6:00 a.m.) up to the gas cap

- Extended-length screens at all six main units

- Juvenile fish monitoring facility/collection and bypass, with capability to either collect and transport fish via barge or truck or release them to the river

- An eight-bay spillway, with deflectors on six middle bays

The Corps will investigate a surface bypass RSW, spillway deflector optimization (including addition of end bay deflectors), and replacing the juvenile bypass system separator, as well as making other system improvements; upgrade extended intake screens; investigate the effectiveness of 24-hour spill, either separately or in conjunction with a surface bypass RSW; implement those measures with the greatest promise of increasing juvenile survival; determine the need and frequency of powerhouse debris containment boom use to reduce predation losses; and implement debris removal criteria.

Lower Granite Dam. Configurations and facilities at Lower Granite Dam related to juvenile fish passage include the following operating criteria identified in the Fish Passage Plan:

- A 12-hour spill from 6:00 p.m. to 6:00 a.m. up to the gas cap

- Extended-length screens at all six main units

- Juvenile fish monitoring facility/collection and bypass, with the capability to either collect and transport fish via truck or barge, or release them to the river

- Prototype powerhouse surface collector

- An eight bay-spillway, with deflectors on eight bays

The Corps will initiate surface bypass RSW studies in 2001; complete design of juvenile bypass system improvements to add open-channel flume, juvenile separation by size, and other system improvements; upgrade extended intake screens; investigate the effectiveness of 24-hour spill, either separately or in conjunction with a surface bypass RSW; investigate spillway deflector optimization and implement it as warranted; defer a decision on permanent powerhouse surface bypass collector until other measures are fully evaluated; implement measures with the greatest promise of increasing juvenile survival; and add additional transport barges as warranted.

9.6.1.4.3 Current and Near-term Actions

Spill Program

Action 54: The Corps and BPA shall implement an annual spill program, consistent with the spill volumes and TDG limits identified in Table 9.6-3, at all mainstem Snake and Columbia River FCRPS projects as part of the annual planning effort to achieve the juvenile salmon and steelhead performance standards.

The annual spill program will be based on the best available monitoring and evaluation data concerning project passage, spill, and system survival research. The Action Agencies, in consultation with the Technical Management Team and with the approval of NMFS, will conduct a preseason determination of the specific annual spill levels and dates at each project. The planning dates for the annual spill program are April 3 to June 20 and June 21 to August 31 for the spring and summer migration periods, respectively, in the Snake River, and April 10 to June 30 and July 1 to August 31 for the spring and summer migration periods, respectively, in the lower Columbia River. Initial estimates of project spill levels, and the basis for each estimate, are shown in Table 9.6-3.

The specific spill volumes listed in Table 9.6-3 must be viewed as approximate because the TDG levels measured at the monitoring site below each project, at a given spill level, can vary with such factors as river flow, forebay dissolved gas level, spill patterns, and water temperature changes. Spill levels at some projects may change as spill patterns are refined or if deflector optimization measures are implemented. There are also project-specific limitations on spill levels for reasons other than TDG, including adult passage, navigation, and research activities. These limitations are typically of short duration, but they can affect spill for fish passage to a limited degree.

Interruptions or adjustments in spill may occur due to unforeseeable power system, flood control, or other emergencies. The Action Agencies should view such emergency actions as last resorts, and they should not be used in place of the long-term investments necessary to allow full, uninterrupted implementation of the required spill levels while maintaining other project purposes, such as an adequate and reliable power system.

Discussion of emergencies with effects of exceptional magnitude or duration should include involvement of regional executives. Section 9.4.2.2 provides for the development of more specific process modifications to address these needs in the water management plans.

9.6.1.4.4 Project-by-project Spill Requirements

Lower Granite Dam. To achieve the desired fish passage efficiencies, the 1995 FCRPS Biological Opinion set the Lower Granite spill level at 80% of total instantaneous discharge for

12 hours per day. Under most conditions, however, this level of spill could not be implemented because the gas cap was reached at spillway flows of 40 kcfs (1998 Supplemental FCRPS Biological Opinion). More recent information suggests that the gas cap will be reached at about 60 kcfs; this level is the appropriate current spill limit. Based on radio-tracking studies with adult chinook, performed at Lower Granite Dam during 1996 and 1997, a spill level of 60 kcfs does not appear to affect adult passage adversely (Bjornn 1998, Bjornn 2000). It may be necessary to reduce spill to accommodate safety concerns when juveniles are being loaded directly onto barges for transportation downstream, and the barges must be docked for extended periods. Spill operations must also consider research needs critical to the ongoing evaluation of the surface bypass prototype (e.g., project operations in 2000 have been modified to spill for 24 hours per day instead of only at night, and powerhouse operations have been modified to provide the required hydraulic conditions in the immediate forebay).

Table 9.6-3. Estimated spill levels and gas caps for FCRPS projects during spring (all) and summer (nontransport projects).

Project[1]	**Estimated Spill Level**[2]	**Hours**	**Limiting Factor**
Lower Granite	60 kcfs	6 p.m. - 6 a.m.	gas cap
Little Goose	45 kcfs	6 p.m. - 6 a.m.	gas cap
Lower Monumental	40 kcfs	24 hours	gas cap
Ice Harbor	100 kcfs (night) 45 kcfs (day)	24 hours	nighttime - gas cap daytime - adult passage
McNary	120-150 kcfs	6 p.m. - 6 a.m.	gas cap
John Day	85-160 kcfs/60% [3] (night)	6 p.m. - 6 a.m.[4]	gas cap/percentage
The Dalles	40% of instant flow	24 hours	tailrace flow pattern and survival concerns (ongoing studies)
Bonneville	90-150 kcfs (night) 75 kcfs (day)	24 hours	nighttime - gas cap daytime - adult fallback

[1] Summer spill is curtailed beginning on or about June 20 at the four transport projects (Lower Granite, Little Goose, Lower Monumental, and McNary dams) due to concerns about low inriver survival rates.

[2] Estimated spill levels shown in the table will increase for some projects as spillway deflector optimization measures are implemented.

[3] The TDG cap at John Day Dam is estimated at 85 to 160 kcfs, and the spill cap for tailrace hydraulics is 60%. At project flows up to 300 kcfs, spill discharges will be 60% of instantaneous project flow. Above 300 kcfs project flow, spill discharges will be at the gas cap (up to the hydraulic limit of the powerhouse).

[4] Spill at John Day Dam will be 7:00 p.m. to 6:00 a.m. (night) and 6:00 a.m. to 7:00 p.m. (day) between May 15 and July 31.

BPA has specified 11.5 kcfs as a minimum powerhouse flow for system reliability. Because this minimum depends on the status of generation at other projects, it may not be necessary at all times.

<u>Little Goose Dam</u>. The 1995 FCRPS Biological Opinion set the Little Goose Dam spill level at 80% of total instantaneous discharge 12 hours per day (NMFS 1998). As at Lower Granite Dam, the Action Agencies could not usually implement this level because the gas cap was reached at spillway flows of approximately 35 kcfs. More recent information suggests that the gas cap will be reached at about 45 kcfs; this level is the appropriate current limit at Little Goose Dam. Based on radio-tracking studies with adult chinook performed during 1997, a spill level of 60 kcfs did not appear to affect adult passage adversely (Peery 1998).

BPA has specified 11.5 kcfs as a minimum powerhouse flow for system reliability. Because this minimum depends on the status of generation at other projects, it may not be necessary at all times.

<u>Lower Monumental Dam</u>. The 1995 FCRPS Biological Opinion set the Lower Monumental Dam spill level at 81% of total instantaneous discharge for 12 hours per day (NMFS 1998). Again, this level of spill was not provided voluntarily, because the gas cap was reached at spillway flows of approximately 40 kcfs. The estimate of spill at the gas cap has not changed. Spill levels to the gas cap will now, however, be provided for 24 hours per day. Based on radio-tracking studies with adult chinook performed during 1997, a spill level of 45 kcfs did not appear to affect adult passage adversely (Peery 1998, Bjornn 2000). Because the gas cap is currently reached at approximately 40 kcfs, no reduction in spill is necessary for adult passage.

Accelerated erosion in the spillway stilling basin apron has recently been noted as a concern by the Corps. NMFS is concerned that the Corps may decide, for safety reasons, to limit fish passage spill until the noted erosion is corrected. To ensure that 24-hour fish passage spill, as described above, is not limited, the Corps and BPA will respond to the problem by initiating timely corrective measures.

BPA has specified 11.5 kcfs as a minimum powerhouse flow for system reliability. Because this minimum depends on the status of generation at other projects, it may not be necessary at all times.

<u>Ice Harbor Dam</u>. The 1995 FCRPS Biological Opinion prescribed spill levels at Ice Harbor Dam of 27% in the spring and 70% in the summer, each for 24 hours per day. The 27% spring objective was often reached, even though the gas cap limited voluntary spill to flows of 25 kcfs. The summer target of 70% was also reached at the lower flow levels (NMFS 1998). Due to the installation of spillway flow deflectors, more recent information suggests that the gas cap will be reached at 100 kcfs. Based on research performed during the early 1980s, adult passage would become a concern at daytime (5:00 a.m. to 8:00 p.m.) spill in excess of 45 kcfs. Recent information from radio-tracking studies performed from 1996 to 1998 suggests that spill levels

from 55 to 70 kcfs did not appear to affect adult passage adversely (Peery 1998, Bjornn 2000). The 45-kcfs, adult-passage daytime cap may have to be reconsidered once the final study results are available. No change is now proposed, however, and the daytime limit remains 45 kcfs.

BPA has specified 7.5 to 9.5 kcfs as minimum powerhouse flows for system reliability. Because this minimum depends on the status of generation at other projects, it may not be necessary at all times.

McNary Dam. The 1995 FCRPS Biological Opinion set the McNary Dam spill level at 50% of total instantaneous discharge for 12 hours per day (NMFS 1998). Due to limited powerhouse capacity, and because the gas cap was reached at spillway flows of 120 kcfs, these spill levels were reached under most conditions. More recent information suggests that the gas cap will be reached at about 135 kcfs.

BPA has specified a minimum powerhouse flow of 50 kcfs to maintain power transmission system stability.

John Day Dam. The 1998 FCRPS Supplemental Biological Opinion set the John Day Dam spill level at 60% of total instantaneous discharge up to the gas cap during the nighttime hours. At project flows up to 300 kcfs, spill discharges will be 60% of instantaneous project flow during 12 hours per day. Above 300 kcfs, spill discharges will be the gas cap (up to the hydraulic limit of the powerhouse). With the completion of spillway deflectors and new spill patterns, gas cap spill flow has ranged up to170 kcfs. Spill limits of 25% minimum and 60% maximum are imposed to ensure adequate juvenile egress conditions from the spillway at low spill flows and from the juvenile bypass system during high spill flows. General physical model studies have indicated that spill percentages below 25% create poor egress conditions (eddies and slack water) in the spillway tailrace, and spill levels above 60% tend to create a large eddy in the tailrace below the powerhouse that can actually cause flow from the bypass to move upstream.

BPA has specified a minimum powerhouse flow of 50 kcfs to maintain power transmission system stability.

The Dalles Dam. The 1995 FCRPS Biological Opinion prescribed a spill level at The Dalles Dam of 64% for 24 hours (NMFS 1998). Spill survival studies NMFS conducted in 1997, 1998, and 1999 indicated that the 64% spill level can result in relatively low spillway survival compared to fish released below the project. These studies also indicated that a 30% spill level spillway survival was always as good or higher than the 64% level. Companion studies using radio-tagged fish and hydroacoustic monitoring indicated that reducing the spill percentage from 64% to 30% caused more fish to pass through the powerhouse sluiceway and turbines. Turbine survival has not been measured at this project, but it is assumed to be no better than that observed at other projects. Details of these studies and references can be found in NMFS 2000a.

Based on the available information, the ISAB recommended an evaluation of 24-hour spill levels at The Dalles in the 30% to 50% range (ISAB 2000). NMFS recommends an evaluation of 24-hour spill at the 40% level and expects to improve juvenile fish survival with this interim spill operation (see Section 9.6.1.4.5). Additionally, because reduced juvenile survival at higher spill levels may have been related to the daylight adult spill pattern, there is potential for higher than 40% nighttime spill with a juvenile passage pattern after The Dalles survival tests are concluded, and the results are evaluated. Upon completion of these tests, modified spill levels and patterns should be evaluated for adult passage and fallback.

BPA has specified a minimum powerhouse flow of 50 kcfs to maintain power transmission system stability.

<u>Bonneville Dam.</u> The 1998 FCRPS Supplement established a nighttime spill level at the TDG cap generally between 90 and 150 kcfs for the duration listed in the current Corps' Fish Passage Plan. The minimum spill level will be no less than 50 kcfs of the total river flow to provide good tailrace egress of juvenile migrants. Daytime spill levels are limited to 75 kcfs at Bonneville Dam due to concerns for adult salmonid fallback through the spillway. Recent evidence from adult radio-tracking studies conducted in 1996, 1997, and 1998 indicates that increases in adult fallback associated with increased daytime spill flows from 75 to120 kcfs range are relatively small. Juvenile passage benefits from the increased spill level would likely outweigh small adult losses that may be associated with the higher spill level. Further, spillway deflector optimization improvements may result in more uniform spill gate openings, which could reduce adult fallback rates. NMFS believes this issue warrants further investigation. Planned studies are described below.

BPA has specified a minimum powerhouse flow of 30 kcfs.

<u>System Actions to Improve Spill Capability</u>

Action 55: To improve the future flexibility of the transmission system, BPA's Transmission Business Line shall initiate planning and design necessary to construct a Schultz-Hanford 500-kV line or an equivalent project, with a planned schedule for implementation by 2004 or 2005.

This line would make additional daytime spill possible in the lower Columbia to help meet performance standards by restoring approximately 200 to 300 MW of California transfer capability. Because construction of this new line will require congressional and NEPA review, BPA's Transmission Business Line should begin this planning effort in 2000.

Action 56: BPA's Transmission Business Line shall continue efforts to evaluate, plan, design, and construct a joint transmission project to upgrade the west-of-Hatwai cutplane[7] and improve the transfer limitations from Montana.

Although the specific type of project to be implemented has not been identified at this time, this project is expected to be completed in the 2003-to-2004 time frame. This upgrade would make additional daytime spill possible at the Snake River dams to help meet performance standards by restoring approximately 500 MW of Montana transfer capability. Since this project will also require NEPA review, BPA's Transmission Business Line should begin this joint planning effort in 2000.

Action 57: BPA's Transmission Business Line shall continue to evaluate strategically located generation additions and other transmission system improvements and report progress to NMFS annually. BPA's Transmission Business Line shall also limit future reservations for transmission capacity, as needed, to enable additional spill to meet performance standards, while minimizing effects on transmission rights holders.

If additional spill is found to be appropriate at FCRPS projects (more than the capacity that the Schultz-Hanford project provides), further transmission system reinforcements may be required to enable obtaining it and restoring any additional lost capacity. BPA's Transmission Business Line has made only a cursory examination of these potential transmission system reinforcements. The most promising candidates are major 500-kV lines in the Interstate Highway 5 (I-5) corridor; however, such new lines would be very costly and challenging to site. If work on these projects started in 2002 (pending favorable results in ongoing spill studies), completion of these reinforcements would be expected in the 2007-to-2010 timeframe. In addition, several new gas-fired combustion turbines south of the John Day cutplane (with a total capacity of about 1,250 MW of base load generation) are being licensed and could be operational by the summer of 2002. If additional spill is found to be appropriate, and before long-term fixes can be implemented, BPA will limit future reservations for transmission capacity, as appropriate, to enable spill while minimizing effects on existing transmission rights holders.

Turbine Unit Operations

Action 58: The Corps and BPA, in coordination with the Fish Passage Operations and Maintenance Coordination Team (FPOM), shall operate all turbine units at FCRPS dams for optimum fish passage survival. Methods to achieve this

[7]Cutplanes are reference points on a set of transmission lines that define capacity restrictions under certain operating conditions or when facilities are out of service. These reference points, when linked together, form a line (or a plane) that defines an operating constraint in the transmission system. That is, there is a limit to the amount of electricity that can flow across this plane. Thus, they are identified with transmission constraints.

objective shall include, but are not limited to, activities outlined in the following paragraphs.

The Corps and BPA will operate turbines within 1% of peak efficiency during the juvenile and adult migration seasons (March 15 through October 31 in the Columbia River and March 15 through November 30 in the Snake River) as indicated by the load-shaping guidelines contained in the Corps' annual Fish Passage Plan. These guidelines will be updated through the Fish Passage Plan review process before February 1 each year. Operating turbines at peak efficiency is believed to provide the highest survival of anadromous species during passage through a turbine (Bell et al. 1981, Eicher 1987).

The Corps and BPA will continue efforts to index-test all families of turbine units specific to each project in the FCRPS to ensure that peak efficiency tables listed in the Fish Passage Plan reflect current operating conditions. This work will be completed by 2003. This will include index testing and development and implementation of operational cam curves. These curves will be developed and updated as necessary to reflect current fish passage conditions (screens, surface collectors, unit modifications, etc.). This work will be coordinated through FPOM.

Action 59: The Action Agencies, in coordination with the Regional Forum, shall determine the appropriate operating range of turbines equipped with minimum gap runners (MGRs) to increase survival of juvenile migrants passing through these new turbine designs.

The Action Agencies will evaluate the potential for exceeding the upper limit of the 1% efficiency band to improve fish survival related to passage through turbines with MGR technology. The evaluation will include an examination of indirect consequences (in terms of fish survival) of exceeding the 1% peak efficiency guidelines (including screen effects, gatewell hydraulics, draft tube and tailrace conditions, etc.). The Action Agencies will report results of this evaluation to NMFS by October 2003. Other turbine designs may be evaluated if study designs and priorities are approved as part of the annual planning process.

9.6.1.4.5 Studies (Including Research, Monitoring, and Evaluations)

<u>Bonneville Dam</u>

Action 60: The Corps and BPA shall evaluate adult fallback and juvenile fish passage under daytime spill to the gas cap at Bonneville Dam in 2002 and 2003, after deflector optimization improvements allow for increased spill above current levels. Research results will be considered, in consultation with NMFS through the annual planning process, to determine implementation of additional changes in spill to further improve fish survival.

Research goals will include rate of adult fallback and juvenile passage change between 75 kcfs and new gas cap spill levels attainable through deflector optimization. The future daytime spill level will depend on the results of this study. The study design for future spill evaluations, and the resulting changes in the annual spill operation, should be coordinated through NMFS' Regional Forum process.

Further modifications to spill operations suggested by the studies at this project for 2002 and beyond may be limited pending transmission system improvements expected to come on-line by 2005 or earlier by potential modifications to spill operations at The Dalles and John Day dams. Other actions may improve the flexibility and reliability of the transmission system by an earlier date.

Action 61: The Corps shall complete the ongoing prototype powerhouse system surface collection evaluations at Bonneville First Powerhouse in 2000. The Corps shall compare the prototype with screened bypass systems and, if warranted, design and construct permanent facilities after full consideration and resolution of biological and engineering uncertainties, especially high-flow outfall investigations.

Existing Bonneville First Powerhouse juvenile passage facilities guide a relatively low percentage of fish away from turbines, and guided fish are bypassed to an outfall site with predator aggregations. The full potential of a surface collection and high-flow bypass outfall system has to be identified, then weighed against other alternatives.

Action 62: The Corps shall complete Bonneville First Powerhouse prototype evaluations of extended submerged intake and gatewell vertical barrier screens, including an assessment of fry passage.

The Corps will continue design development of improved screens, a downstream migrant collection channel, and connection to the new juvenile bypass monitoring facilities and outfalls.

Action 63: The Corps shall complete the design of debris removal facilities for the Bonneville First Powerhouse forebay.

If the decision is made to install a new extended-length screen and bypass system at this powerhouse in 2001, the Corps will install debris-removal facilities as warranted. Special consideration should be given to potential predation and juvenile fish entrainment problems associated with debris booms.

Action 64: The Corps shall continue the investigation of minimum gap runners at the Bonneville First Powerhouse.

The Corps will continue investigation of the new minimum gap runners at Bonneville Dam First Powerhouse to ensure that the new runner environment provides improved survival for juvenile migrants that pass through turbines. The Corps will submit a report to NMFS stating the findings of these investigations by February 2001.

Action 65: The Corps shall complete Bonneville Second Powerhouse post-construction evaluation of the new juvenile fish bypass outfall and address design and operational refinements as warranted.

Issues such as smolt survival, fry impingement and loss, and potential design deficiencies will have to be investigated and corrected, as necessary.

Action 66: The Corps shall continue design development and construction of a Bonneville Second Powerhouse permanent corner collector at the existing sluice chute, pending results of high-flow outfall investigations. The Corps shall construct new facilities if, and as soon as, evaluations confirm the optimum design configuration and survival benefits.

Prototype testing in 1998 showed that numerous juveniles entering the forebay were collected by the sluice chute. The decision to proceed with this measure is contingent on identifying whether an optimum bypass outfall location can be selected that will minimize mechanical and predation losses in the tailrace.

Action 67: The Corps shall continue Bonneville Second Powerhouse investigations of measures to improve intake screen fish guidance efficiency and safe passage through the gatewell environment. This work shall include an assessment of fry passage.

The Bonneville Second Powerhouse bypass system has a state-of-the-art fish conveyance system coupled with relatively low fish guidance efficiency. Improving guidance of this system is an obvious next step to improving powerhouse passage, pending decisions on the optimal mix of actions at the second powerhouse for contributing to the performance standard.

<u>The Dalles Dam</u>

Action 68: The Corps and BPA shall continue spill and passage survival studies at The Dalles Dam in 2001. Research results shall be considered, in consultation with NMFS through the annual planning process, to assess the need for additional changes in spill to further improve fish survival by 2002, if possible, but no later than 2005.

The goal of these studies is to evaluate spillway survival by using a spill level that balances the risks associated with high spill levels and increased turbine passage. These studies should also include evaluation of survival rates through the other routes of passage at this project. These studies should investigate the causes of spillway mortality. Subsequent studies should assess the need for remedial actions.

Future changes in spill levels at The Dalles will depend on the results of the ongoing survival and spill passage studies. The study design for any future studies, and the resulting changes in the annual spill operation, will be coordinated through the annual planning process.

Further modifications to spill operations suggested by the studies at this project for 2002 and beyond may be limited pending transmission system improvements expected to come on line by 2005 or, before then, on potential modifications to spill operations at Bonneville and John Day dams. Other actions may improve the flexibility and reliability of the transmission system by an earlier date.

Action 69: The Corps shall continue design development and 2001 prototype testing of upper turbine intake occlusion devices at The Dalles, with a goal of increased non-turbine passage rates through either the sluiceway or the spillway. The Corps shall install occlusion devices across the entire powerhouse, as warranted.

Occlusion of upper intakes is a promising method of reducing turbine entrainment and associated mortality.

Action 70: The Corps shall continue biological and engineering investigations and design of a composite ice and trash sluiceway outfall relocation and adult ladder auxiliary water system at The Dalles Dam and shall construct such devices as warranted.

The existing ice and trash sluiceway is a highly efficient surface collector. However, recent PIT-tag survival data suggest that survival is unacceptably low. Relocation of the outfall to improve passage survival will also provide the opportunity to develop a combined system whereby excess water can be used to augment the auxiliary water supply for the east adult fishway.

John Day Dam

Action 71: The Corps and BPA shall continue investigation of 24-hour spill at John Day Dam in 2001. Research results will be considered, in consultation with NMFS through the annual planning process, to determine implementation of daytime spill to further improve juvenile fish survival as needed for its contribution to the performance standard.

High spillway effectiveness and high daytime passage were noted during 24-hour spill in 1997 and 1999. The 1999 studies indicated a significant reduction in forebay residence time for chinook and smaller (primarily wild) steelhead. These observations and the study limitations imposed by ambient flow conditions in 1999 warrant further investigation during the spring and summer seasons in 2001.

The framework for the ongoing study is as follows:

- The study goals identify juvenile salmonid response to daytime spill in terms of spillway passage, forebay residence time, and overall passage survival.

- The scope of the study will include both spring and summer spill.

- Adult passage considerations and potential adult fallback will be considered in the study design.

- The study plan will be reviewed through the annual planning process.

Further modifications to spill operations suggested by project studies for 2002 and beyond will be coordinated through the annual planning process and may be limited pending transmission system improvements expected to come on line by 2005. Other actions may improve the flexibility and reliability of the transmission system by an earlier date.

Action 72: The Corps shall continue design development of a prototype RSW and extended deflector for testing at John Day in 2002. The Corps should synthesize evaluation results, determine the fish survival benefits of one or more RSWs or a skeleton bay surface bypass, and install the units as warranted.

Surface-oriented entrances, such as those provided by a prototype RSW, have the potential to pass a high percentage of juveniles, potentially more than if the same flow is passed through the deeper conventional spill gates.

Action 73: The Corps shall continue John Day prototype development and investigations of extended submerged intake screens, gatewell vertical barrier screens, and, if necessary, orifices to optimize guidance and safe passage through the system, including a gatewell debris cleaning plan. This work shall include an assessment of fry passage. The Corps shall design and construct new screen systems for safe passage of juvenile salmonids, as warranted. Juvenile bypass outfall survival investigations shall also be conducted.

Prototype investigations have indicated that extended screens have the potential to guide up to 28% more juvenile salmon away from the turbine intakes at this project when compared to standard-length screens. Unfortunately, gatewell hydraulics were found to injure an unacceptable number of the guided fish. Model and prototype investigations are necessary to resolve the injury problem and provide safe passage conditions observed at other projects with extended-length screens. To ensure improved guidance results and improved passage survival, bypass outfall survival investigations should also be conducted.

McNary Dam

Action 74: The Corps shall continue evaluations to assess the need for improvements of the existing intake screens, gatewell vertical barrier screen cleaning system, and bypass facilities (including debris containment and removal systems, separation, sampling, loading, and outfall facilities) at McNary to determine where improvements are necessary to reduce problems experienced during the 1996 flood, increase fish survival, and resolve holding and loading facility problems, including raceway jumping by juvenile salmon and steelhead and debris plugging of bypass lines. Additionally, the Corps shall evaluate whether the existing juvenile bypass system outfall should be relocated.

The McNary Dam juvenile fish intake screening and bypass system experienced the most adverse effects associated with 1996 flooding and is the passage facility most in need of upgrades. The Corps will implement improvements as warranted.

Action 75: The Corps shall investigate a surface bypass RSW at McNary Dam, based on prototype results at other locations, and shall install the unit in multiple spillway bays, as warranted.

The potential for improved spillway passage through use of RSWs has to be investigated in the context of current spillway passage percentages for spring migrants at McNary Dam, where there is currently no spring transportation program and no voluntary fish spill during the 12 daytime hours.

Lower Monumental Dam

Action 76: The Corps shall investigate, design, and construct, as warranted, a new juvenile bypass outfall at Lower Monumental Dam. Investigations shall be conducted in conjunction with spillway deflector and spill pattern optimization studies.

The existing outfall site is poor because the tailrace current frequently flows upstream toward the powerhouse, and the outfall facilities recently were damaged by a transport barge. The new outfall shall be designed to return both PIT-tagged fish and primary bypass flow to the river.

Action 77: The Corps shall investigate surface bypass (e.g., RSW) at Lower Monumental Dam, based on prototype results at other locations, and install in multiple spillway bays, as warranted.

Use of one or more RSWs at Lower Snake hydro projects will potentially increase safe spillway passage during periods of low to moderate spill.

Action 78: The Corps shall initiate design development and testing of extended submerged intake screens and vertical barrier screens at Lower Monumental Dam and construct units as warranted.

Lower Monumental Dam presently has standard screens. Improved fish guidance efficiency would enhance survival of fish entrained at powerhouse turbine intakes by diverting a higher proportion away from turbine passage where they are subject to direct mechanical and/or indirect mortality.

<u>Little Goose Dam</u>

Action 79: The Corps shall conduct a post-construction evaluation of the new debris containment boom at Little Goose to monitor populations and behavior of aquatic predators when debris accumulates at the log boom.

The Corps should develop criteria for initiation of debris removal at the new log boom before the 2002 passage season and assess log boom predator aggregation in both wet and dry years. The Corps will alter criteria and address predation, as warranted.

<u>Lower Granite Dam</u>

Action 80: The Corps shall continue the design development, fabrication/deployment, and testing of a prototype RSW at Lower Granite, in conjunction with the existing prototype powerhouse occlusion devices, including the forebay behavioral guidance structure (BGS) and upper turbine intake occlusion devices. As warranted by prototype test results, the Corps shall install one or more permanent RSWs and occlusion devices at appropriate lower Snake hydro projects, in coordination with the annual planning process.

Use of one or more RSWs, in possible combination with occlusion systems at lower Snake hydro projects, will potentially increase safe spillway passage and survival, reduce forebay residence time, reduce stress, and potentially reduce gas supersaturation due to higher spillway passage efficiencies.

Action 81: The Corps shall complete design for new juvenile bypass facilities at Lower Granite Dam, including enlarged orifices and bypass gallery, open-channel flow bypass, improved separator for juvenile separation by size, and improved fish distribution flumes and barge-loading facilities and shall proceed to construction, as warranted.

Lower Granite is the first mainstem dam on the Snake River encountered by migrating juvenile salmon and steelhead. This location offers the greatest potential for collecting the largest number of smolts for transportation. Unlike the other dams, there is presently no way to separate juvenile fish by size. Such size separation is believed to reduce stress and enhance long-term survival. Juvenile collection/bypass facilities at all of the other collector projects have been upgraded with state-of-the-art improvements over the last decade. These improvements are necessary, while additional information on the benefits of transportation is collected.

9.6.1.4.6 System or General Studies (including Research, Monitoring, and Evaluations)

Action 82: The Action Agencies, in coordination with NMFS through the annual planning process, shall investigate the spillway passage survival of juvenile salmonids at appropriate FCRPS dams. These investigations shall assess the effect of spill patterns and per-bay spill volumes on fish survival, across a range of flow conditions. The Action Agencies shall develop a phased approach (including costs and schedules) and set priorities, in consultation with NMFS in the annual planning process, to continue spillway passage survival studies in 2001 and future years.

Spillway passage has become an increasingly important route for juvenile salmonids at FCRPS dams. These studies will ensure that each spillway is operated in a manner that results in the lowest possible direct and indirect mortality.

Action 83: The Action Agencies, in coordination with NMFS through the annual planning process, shall evaluate the effect of spill duration and volume on spillway effectiveness (percent of total project passage via spill), spill efficiency (fish per unit flow), forebay residence time, and total project and system survival of juvenile steelhead and salmon passing FCRPS dams. Studies shall include both collector and non-collector projects. Adult passage considerations and potential adult fallback shall also be considered in study designs. Little Goose and Lower Granite dams shall be specifically considered for daytime spill studies. An overall phased study approach for spill evaluations will be determined in the 1- and 5-year implementation plans.

Whereas the current nighttime spill regime is based on NMFS' understanding of hours of peak daily juvenile fish passage, it is clear that fish move throughout the day and that, as a result, longer spill hours may improve juvenile fish survival past the dams by increasing the proportion of fish passing in spill. Spill changes to improve fish survival may include reshaping current volumes or spilling increased volumes. There may also be operational changes associated with spill patterns or hourly project operations that influence the proportion of fish passed through spill.

It may also be possible to reduce delay when fish first encounter the dam and, thereby, limit exposure to predation in project forebays. Conversely, longer spill hours could have negligible-to-measurable adverse biological effects, such as delay, fallback of adults, or increased exposure to dissolved gas supersaturation. The intent of the efficiency and effectiveness information is to ensure optimal use of current and future spill volumes to achieve the biological performance standards. Any resulting changes in the annual spill operation will be coordinated through the annual planning process.

The research actions called for above are proposed to further evaluate the fish spill program at selected projects. In addition, NMFS believes that obtaining and reviewing the results of these evaluations will assist in making appropriate future modifications in the spill program to improve both fish survival and water quality.

To the extent that greater spill duration and/or volumes are required for the purposes of spill evaluation at some projects, efforts will be made to minimize or offset additional effects to the power system.

Action 84: The Corps shall continue high-flow outfall investigations to determine whether it is appropriate to modify bypass outfall criteria in the context of high-discharge bypass discharges.

Development of high-flow outfalls for surface collector/bypass systems requires verification of negligible mechanical and predation losses as flow plunges into the tailrace at high velocities. This research is relevant at numerous sites.

Action 85: The Corps shall continue to develop and evaluate improved fish-tracking technologies and computational fluid dynamics (numerical modeling). The ability to integrate these technologies and fluid dynamics shall be assessed as a potentially improved means of determining fish responses to forebay hydraulic conditions.

More precise understanding of fish behavioral responses to forebay hydraulic and other conditions is required to optimize future fish collection and bypass system designs. Integrated use of improved fish tracking and numerical modeling offers the potential for research advances that will lead to survival enhancement measures.

Action 86: The Corps shall continue to investigate a way to increase entry rates of fish approaching surface bypass/collector entrances.

Deep, wide surface collector entrances, similar to the successful Wells Dam surface collector system, have been studied at Corps prototype sites, but performance has been marginal. Therefore, a study is needed to evaluate fish behavior and flow-fields of large surface-oriented entrances that are believed to be highly efficient and effective, such as The Dalles ice and trash sluiceway.

Action 87: The Corps and BPA shall assess less-intrusive, PIT-tag interrogation methods at FCRPS juvenile bypass systems with interrogation sites, including McNary, John

Day, and Bonneville dams. The Corps and BPA shall also assess providing a similar detection capability for the Ice Harbor juvenile bypass system.

The Corps and BPA should assess the use of full bypass flow PIT-tag detection, without the need to dewater and route fish through separators and sample flumes. This type of system reduces the potential for adverse survival effects of passage through these bypass systems.

Action 88: The Corps and BPA, in coordination with the Fish Facility Design Review Work Group and the Fish Passage Improvement Through Turbines Technical Work Group, shall continue the program to improve turbine survival of juvenile and adult salmonids.

Action 89: The Action Agencies shall investigate hydraulic and behavioral aspects of turbine passage by juvenile steelhead and salmon through turbines to develop biologically based turbine design and operating criteria. The Corps shall submit a report to NMFS stating the findings of the first phase of the Turbine Passage Survival Program by October 2001. Annual progress reports will be provided after this date.

Action 90: The Action Agencies shall examine the effects of draft tubes and powerhouse tailraces on the survival of fish passing through turbines.

The evaluation should include biological and hydraulic evaluations and, if warranted, implementation of measures to reduce the effects of turbine backroll on juvenile salmonid survival, as well as the potential for reducing physical and hydraulic predator habitat in the tailrace environment. Action should also be taken to close draft tube gate closure slots at dams where these exist.

Action 91: The Action Agencies shall remove all unnecessary obstructions in the higher velocity areas of the intake-to-draft tube sections of the turbine units.

Unnecessary obstructions include miscellaneous hardware attachment points, handles, bolt heads, etc. Methods to streamline escape ladders, flow splitters, and other necessary obstructions should be evaluated and implemented, if feasible.

Action 92: The Action Agencies shall consider all state-of-the-art turbine design technology to decrease fish injury and mortality before the implementation of any future turbine rehabilitation program (including any major repair programs, the ongoing rehabilitation program at The Dalles Dam, and any future program at Ice Harbor Dam). The Action Agencies shall coordinate within the annual planning process before making decisions that would preclude the use of fish-friendly technologies and to minimize any adverse effects of project downtime.

Action 93: The Action Agencies shall determine the number of adults passed through turbines, then, if warranted, investigate the survival of adult salmonid passage through turbines (including steelhead kelts).

This program will include baseline passage evaluation and survival estimates and an investigation of hydraulic and behavioral aspects of turbine passage. This information will be used to develop biologically based turbine design and operating criteria.

Action 94: The Corps shall continue to evaluate the need for improvements of the existing intake screens, gatewell vertical barrier screens' cleaning system, and bypass facilities (including debris containment and removal systems, separation, sampling, loading, and outfall facilities) at the four lower Snake River hydropower projects.

The objective of these investigations is to upgrade intake screen, bypass, and loading facilities to modify and/or incorporate new components, especially in cases where problems have been identified since original design and construction. This includes investigation and implementation of measures to reduce raceway jumping.

Action 95: The Corps shall complete investigations of improved wet separator designs in 2002. The Corps shall design and construct a new wet separator at McNary, Lower Monumental, and Little Goose dams, as warranted.

The Corps will conduct post-construction evaluations of improved juvenile fish separation performance.

Action 96: The Corps shall complete the extended submerged intake screen systemwide letter report and implement recommended improvements.

The Corps will complete an investigation of fish performance and engineering issues pertaining to the need for improved porosity-control panel and panel connection design and install improved panels in all extended submerged intake screens. In particular, the Corps will develop improved vertical barrier screen gatewell cleaning and inspection measures for McNary and John Day dams and implement them as warranted. Also, the Corps will develop improved debris handling measures in the forebays and screen/bypass systems to limit juvenile injury and mortality. The Corps will implement other measures related to extended-length screen improvements, as warranted.

9.6.1.4.7 Configuration Alternatives and Decision Dates

Bonneville Dam—First Powerhouse

Action 97: By January 2002, the Action Agencies shall develop an analysis that compares the relative passage survival benefits of an extended-length, intake screen bypass system, a surface-collection bypass system, and hybrid alternatives at Bonneville First Powerhouse. Through the annual planning process, the Corps shall determine which of these configurations to implement.

Two configuration alternatives are under evaluation for an improved bypass system at Bonneville First Powerhouse. One alternative completely upgrades the existing conventional bypass system by replacing the standard-length intake screens with extended-length screens, upgrading the collection gallery, and relocating the outfall. The other alternative employs the developing surface attraction and collection technology in front of the powerhouse and passes juveniles in a collection channel to a new outfall site downstream. Intake screens and surface collection may work best in tandem, suggesting that a hybrid of the two systems may be a third alternative configuration. The decision on which alternative to implement may be made as early as January 2001, but no later than January 2002.

John Day Dam

Action 98: By January 2003, the Action Agencies shall develop an analysis that compares the relative passage survival benefits of replacing existing standard-length intake screens with extended-length screens at the John Day Dam powerhouse to surface collection at one or more skeleton or spillway bays. Through the annual planning process, the Action Agencies shall then determine the need for, and the implementation priority of, these configuration alternatives.

Two different configuration alternatives are currently under evaluation at John Day Dam. Extended-length screens have been under development and evaluation for several years. Evaluation to date has indicated that the screens increase FGE. In 1999, research confirmed excessive mortality in the gatewells. Excessive gatewell turbulence is suspected as the cause of the mortality, and a new vertical barrier screen design is being developed. Surface collection technology has yet to be evaluated at John Day Dam. An RSW is under development for prototype evaluation in 2002. This requires that the Action Agencies make a determination by 2003, through the annual planning process, about the need for and implementation priority of these alternatives at John Day.

Lower Monumental Dam

Action 99: By January, 2003, the Action Agencies shall develop an analysis that compares the relative passage survival benefits of replacing existing standard-length intake screens with extended-length screens at the Lower Monumental Dam powerhouse turbines to a removable RSW surface bypass system.

Twenty-four-hour spill was implemented at Lower Monumental Dam in spring 2000. Configuration alternatives include extended intake screens and one or more RSWs. Extended intake screen performances at other sites are known, and RSW fish passage efficiency will be studied at Lower Granite Dam in 2001. The Action Agencies will determine, through the annual planning process, which configuration alternatives to test or implement at Lower Monumental Dam.

9.6.1.5 Reservoir Passage

In general, juvenile mortality in reservoirs typically is associated with predation. While predation may be the primary cause of mortality, many factors contribute to vulnerability to predation, including water temperature, delay of passage or migration, TDG supersaturation, fish condition, disease, turbidity, lack of cover, etc. Various ongoing measures that directly reduce predation of juvenile outmigrants (e.g., Northern Pikeminnow Management Program) or may indirectly affect potential predation (water management, including releases of cool water, 24-hour spill, spill patterns, avian lines, water cannons, etc.) should continue. The Action Agencies should also develop other approaches that may contribute to reducing reservoir mortality.

9.6.1.5.1 Predator Control Strategy. The riverine ecosystems of the lower Snake and lower Columbia rivers have been altered dramatically by the development of the FCRPS. This development, and associated fish management practices, has created an environment that has benefitted a variety of species that prey on juvenile and adult salmonids. Studies cited in the Predation White Paper (NMFS 2000f) indicate that relatively large numbers of juvenile salmonid migrants are eaten by a variety of piscivorus fish, birds, and marine mammals. The northern pikeminnow alone is responsible for the loss of approximately 8% of the juvenile salmonid migrants in the system, and gulls were estimated to take 2% of all migrants passing one Columbia River dam. Marine mammal damage has been observed on up to 19% of the adult spring/summer chinook passing Lower Granite Dam. NMFS recognizes that death, injury, and health problems resulting from dam and reservoir passage and the presence of non-indigenous predator species are issues that will persist regardless of how predation is managed. It also recognizes that native predators are a part of the river ecosystem. Nevertheless, NMFS believes that some degree of predator control is necessary and that the following measures will help achieve the survival performance goals identified in this biological opinion, particularly related to the 10% reduction in reservoir mortality estimates.

9.6.1.5.2 Current and Near-term Actions

Action 100: The Action Agencies shall continue to implement and study methods to reduce the loss of juvenile salmonids to predacious fishes in the lower Columbia and lower Snake rivers. This effort will include continuation and improvement of the ongoing Northern Pikeminnow Management Program and evaluation of methods to control predation by non-indigenous predacious fishes, including smallmouth bass, walleye, and channel catfish.

Northern pikeminnow, smallmouth bass, channel catfish, and walleye are important predators of juvenile salmon (Poe et al. 1991, Tabor et al. 1993). Various studies conducted in the 1980s indicated that northern pikeminnow predation in John Day Reservoir alone consumed between 1.4 and 3.3 million juvenile salmonids each year. Predator control efforts to date have focused on removing northern pikeminnow from the Snake and Columbia rivers and evaluating the behavior and distribution of predators in the near-dam and reservoir reaches. Additional emphasis should be placed on other predatory species in areas where those species cause significant loss of juvenile salmonids (see Section 9.6.1.5.3, below).

The effects of predator fish removal, habitat modifications, and management operations should be evaluated periodically as long as the programs continue. Such evaluation should include the effect on juvenile salmon survival, changes in target predator species population structures, and possible compensation by other predatory species.

Action 101: The Corps, in coordination with the NMFS Regional Forum process, shall implement and maintain effective means of discouraging avian predation (e.g., water spray, avian predator lines) at all forebay, tailrace, and bypass outfall locations where avian predator activity has been observed at FCRPS dams. These controls shall remain in effect from April through August, unless otherwise coordinated through the Regional Forum process. This effort shall also include removal of the old net frames attached to the two submerged outfall bypasses at Bonneville Dam. The Corps shall work with NMFS, FPOM, USDA Wildlife Services, and USFWS on recommendations for any additional measures and implementation schedules and report progress in the annual facility operating reports to NMFS. Following consultation with NMFS, corrective measures shall be implemented as soon as possible.

Bird predation marks are among the most common injuries observed on juvenile steelhead at smolt monitoring sites. During 1995 and 1996, 15% and 10%, respectively, of all the hatchery steelhead examined at John Day Dam exhibited bird predation marks (Martinson et al. 1997). These observations may indicate a high rate of juvenile steelhead predation that could be reduced with appropriate measures. The net frames at Bonneville Dam are no longer used for research and have become favored perching areas for fish-eating cormorants and gulls. The Corps will coordinate scoping and implementation of predator control measures with USFWS to ensure that the measures do not endanger bald eagles, osprey, and other bird species that are afforded Federal protection.

Any avian control measure involving capture or killing of migratory birds will require a permit issued by USFWS under the procedures and standards set out in the Migratory Bird Treaty Act and in USFWS's implementing regulations.

9.6.1.5.3 Studies (Including Research, Monitoring, and Evaluation)

Action 102: The Action Agencies, in coordination with the Caspian Tern Working Group, shall continue to conduct studies (including migrational behavior) to evaluate avian predation of juvenile salmonids in the FCRPS reservoirs above Bonneville Dam. If warranted and after consultation with NMFS and USFWS, the Action Agencies shall develop and implement methods of control that may include reducing the populations of these predators.

Gulls, terns, pelicans, common mergansers, and other birds consume juvenile salmonids in the Columbia and Snake rivers (Meacham and Clark 1979 in Bevan et al. 1994, Ruggerone 1986 in Bevan et al.1994, Bevan et al. 1994, and Wood 1987). The combined effect of this predation on listed stocks is unknown, but the increasing colonies of Caspian terns, California and ring-billed gulls, and white pelicans could have a substantial effect on limited fish populations. A study of gull predation in the upper Columbia River in 1986 indicated that 2% of the juvenile salmonids passing Wanapum Dam were consumed. Additional infomation on consumption rates, migration patterns, and the ultimate effect on fish populations is needed before sound management decisions can be made. This effort must be coordinated with ongoing avian control activities in the Columbia River estuary and with the USDA Wildlife Services and USFWS.

Action 103: The Action Agencies shall quantify the extent of predation by white pelicans on juvenile salmon in the McNary pool and tailrace. A study plan shall be submitted to NMFS by September 30, 2001, detailing the study objectives, methods, and schedule. Based on study findings, and in consultation with USFWS and NMFS, the Action Agencies shall develop recommendations and, if appropriate, an implementation plan.

Up to six dozen white pelicans have been observed along the Oregon shore a short distance below the McNary Dam juvenile facility during the spring migration. Additional data are needed to determine the extent of pelican predation on salmonids.

Action 104: The Action Agencies shall recover PIT-tag information from predacious bird colonies and evaluate trends, including hatchery-to-hatchery and hatchery-to-wild depredation ratios.

Evaluation of this information, when combined with bird and fish behavioral information, will help managers develop a better understanding of issues such as prey selection, stock-specific vulnerability, and potential long-term predation effects on specific listed stocks, including effectiveness of management actions to reduce predation by birds.

Action 105: The Action Agencies shall develop a pilot study to assess the feasibility of enhancing the function of ecological communities to reduce predation losses and increase survival in reservoirs and the estuary.

The pilot study should include a combination of hydrosystem operations, enhancement of mainstem and estuarine habitat, and directed fishery management options. Information for the near-term studies would serve as the basis for a longer-term effort to enhance habitat and community function within the mainstem corridor. Issues to evaluate include natural and manmade habitat alterations, reservoir level fluctuations during predator spawning seasons, sport fish management options, and sediment and nutrient transport.

Action 106: The Action Agencies, in coordination with NMFS, shall investigate marine mammal predation in the tailrace of Bonneville Dam. A study plan shall be submitted to NMFS by June 30, 2001, detailing the study objectives, methods, and schedule.

From 1990 through 1993, the annual incidence of marine mammal tooth and claw abrasions on fish examined at the Lower Granite adult trapping facility ranged between 14% and 19% for spring-summer chinook, and between 5% and 14% for steelhead. The proportion of adults examined that had open wounds ranged from 5% to 6% for chinook and 1% to 6% for steelhead (Harmon et al. 1994). The prevalence of these abrasions was generally higher during the earliest portion of the run, with reported incidence of 30% on the chinook in 1993 (Harmon et al. 1995). Based on the severity of the observed signs, NMFS speculates that many fish injured by marine mammals die before reaching this project. Marine mammal predation occurs in the near-ocean, estuary, and lower Columbia River up to Bonneville Dam. On many occasions, California sea lions have been observed feeding on adult salmon (primarily spring chinook) near the fishway entrances below Bonneville Dam. While predation by marine mammals in the lower river is not a result of the FCRPS, site-specific predation immediately below FCRPS dams (i.e., Bonneville) is, in part, a result of the presence and operation of the dam. Evaluation of this predator activity should include development of remedial methods that may include relocation or lethal removal. This effort must be coordinated with ongoing marine mammal control activities in the Columbia River estuary and near-ocean.

9.6.1.6 Adult Passage and Research

The actions described in this section represent the best starting point for planning future capital investment in measures to improve the survival of adult salmon migrating past the Corps mainstem FCRPS dams. The specific list of measures to be implemented, their priority, and the method of evaluation will be developed in the 1- and 5-year plans described in Section 9.4. As determined through the annual planning process in Section 9.4, other combinations of measures may also be deemed sufficient to meet the juvenile and adult performance standards and, thus, will avoid jeopardy.

In many cases, the measures described are limited to prototype or facility development and evaluation and include statements that the Action Agencies are expected to implement the results "as warranted." The intent of the measures in these cases is to proceed to implementation upon completion of testing, unless the results of the evaluation present additional problems that have to be addressed through further testing.

9.6.1.6.1 Adult Fish Passage Strategy. A primary objective of this RPA is to maximize direct survival of upstream migrating adult fish at the Federal hydrosystem dams with passage facilities and to minimize indirect (prespawning) mortality in intervening reservoirs and upstream of the hydrosystem. To achieve this objective, the RPA expands investigations of adult passage problems in order to identify direct and indirect mortality-related problems and implement needed improvements. The following research and configuration action items are meant to accomplish six objectives:

- Reduce site-specific and cumulative delay (including fallback over spillways, fallback through turbines and intake screen/bypass systems, and fallback/fallout from fishways).
- Identify correctable project-related direct mortality factors.
- Enhance headburn investigations.
- Protect downstream migrating adult steelhead post-spawners (kelts).
- Improve auxiliary water system diffusers to minimize risk of potential failure (and risks to adult migrants).
- Identify factors related to prespawning mortality of fish that have passed through the FCRPS hydrosystem.

9.6.1.6.2 Studies and Measures (including Research, Monitoring, and Evaluations)

Action 107: The Action Agencies shall conduct a comprehensive evaluation to assess survival of adult salmonids migrating upstream and factors contributing to unaccounted losses.

Broad objectives for such studies may include the following:

- Evaluate survival rates between dams and through the system.
- Partition interdam losses by factor.
- Assess causal mechanisms associated with losses.

- Assess reproductive success, including causal mechanisms associated with reduced reproductive success, if any.
- Identify measures, as appropriate, to address factors affecting passage, survival, and reproductive success.

More specific investigations may include the following:

- Fallback (operational related versus other factors)
- Passage delay (relative to project and reservoir operations, including turbines, spill, and peaking)
- Injury (resulting from passage, marine mammals)
- Headburn
- Homing/straying
- Mainstem spawning
- Tributary turnoff and spawning
- Effect of TDG supersaturation
- Effect of temperature (including use of cool water microhabitat)
- Energy expenditure
- Susceptibility to disease
- Unaccounted incidental mortality associated with harvest
- Cumulative effects (synergism)

Action 108: The Corps and BPA shall conduct a comprehensive evaluation to investigate the causes of headburn in adult salmonids and shall implement corrective measures, as warranted.

While the exact cause of headburn remains unknown (NMFS 2000e), Elston (1996) conducted clinical evaluations of fish with typical headburns from Lower Granite Dam and suggested that headburns were caused by mechanical abrasion and laceration, rather than by necrosis associated with subcutaneous emphysema from GBT. NMFS monitoring at Lower Granite Dam from 1993 through 1999 showed that the rate of incidence of adult spring chinook with headburn ranged from 0% to 9.8% (NMFS 2000e). Bjornn et al. (1995) found in 1993 that of 66 radio-tagged chinook salmon with head scrapes or injuries, 38% did not migrate to known spawning areas and were classified as possible prespawning mortalities. Thus, headburn could be related to a chinook prespawning mortality rate of approximately 2%. This was calculated by multiplying the average of the monitored incidence range (4.9%) times the percentage of head-injured chinook that did not migrate (38%) [4.9% x 38% = 1.9%]. This implies that corrective measures could potentially boost adult spring chinook survival as high as 2% on average.

An example of corrective measures would be investigating the potential benefit of replacing existing spill gate closure (sill) seals, in conjunction with improved connector designs, which are benign to large fish that fall back through the spillway. It is possible that this could reduce the incidence of headburn injury.

Action 109: The Corps shall initiate an adult steelhead downstream migrant (kelt) assessment program to determine the magnitude of passage, the contribution to population diversity and growth, and potential actions to provide safe passage.

Data acquired through sampling in the Lower Granite and Little Goose Dam bypass systems during the peak fallback season of April through June 2000 were used to arrive at a preliminary estimate of 16,745 steelhead kelts present in the Lower Snake River at Lower Granite Dam during the study period (Evans and Beaty 2000). This abundance level represents 22% of the 74,440 adult steelhead counted passing Lower Granite in 1999 (Fish Passage Center 2000, counts for 1999). Theoretically, reconditioning and/or kelt downstream transportation could significantly increase the likelihood of a second spawning opportunity for many of these fish. Also, their downstream in-river survival could be increased by simply providing more effective alternative passage routes to avoid the higher mortality associated with turbine passage.

Evaluations should be conducted to review available literature and develop pilot testing regarding reconditioning of kelts. The Corps will assess and conduct a short-term holding evaluation at a project site where kelt are more abundant and initiate a kelt transportation pilot study as a possible means of reducing dam passage mortality. The Corps will evaluate kelt passage associated with the RSW at Lower Granite Dam (described in Section 9.6.1.4), which will be prototype-tested in 2001 in the context of juvenile fish passage. The Corps will synthesize these work elements and report the magnitude of kelt passage, effects of passage on survival, and potential actions to improve survival, if deemed appropriate, to NMFS' Regional Forum by September 2003.

Action 110: The Corps shall use information from previous and ongoing investigations regarding the problem of adult steelhead holding and jumping in the fish ladders at John Day Dam, develop a proposed course of action, and implement it, as warranted.

This problem has been investigated in a fragmented manner for years. A more detailed collation of cumulative work to date is required, combined with an assessment of alternatives.

Action 111: The Corps shall investigate and enumerate fallback of upstream migrant salmonids through turbine intakes at all lower Snake and lower Columbia River dams. The Corps shall implement corrective measures to reduce turbine mortality, as warranted.

Between 1996 and 1998, fallback rates for spring/summer chinook were between 11 to 15% and 9 to 13% at The Dalles and John Day dams, respectively. In 1996 and 1997, fallback rates for steelhead were between 7 to 10% and 11 to 13% at The Dalles and John Day Dams, respectively (NMFS 2000e, p 88). Keefer and Bjornn (1999) used radio-tagged adults known to have passed Bonneville Dam in 1996 to estimate survival to tributaries or to the top of Priest Rapids Dam. Steelhead and spring/summer chinook salmon that did not fall back over any dam had survival rates that were 3.0 to 5.4% higher than fish that did fall back. Mendel and Milks (1996) estimated that the fallback of fall chinook salmon at Lower Granite Dam was 16 to 39% in 1993 and 30 to 41% in 1992. They estimated fall chinook fallback mortality at 26 and 14% in 1993 and 1994, respectively, for fish that fell back through one or more of the four lower Snake River dams. This higher mortality for fall chinook occurred during periods of no spill, when fallback was assumed to have been through turbines. This information on the rate of fallback and the reduced survival due to fallback can be used to estimate the theoretical gain in survival that could be achieved by corrective measures. For spring/summer chinook, multiplying the 11% observed average rate of fallback at John Day Dam between 1996 and 1998 times the 4.2% higher survival rate, on average, observed for fish that did not fall back implies a potential survival rate increase of .5% [11% x 4.2% = .46%]. For steelhead, multiplying the 12% observed average rate of fallback at John Day Dam between 1996 and 1997 times the 4.2% higher survival rate, on average, observed for fish that did not fall back implies a potential survival rate increase of .5% [12% x 4.2% = .50%]. For fall chinook, multiplying the 28% estimated average fallback rate at Lower Granite in 1993 times the 26% estimated mortality rate for fish that fell back through one or more of the Lower Snake dams in 1993 implies a potential survival rate increase of 7% [28% x 26% = 7.3%].

Corrective measures to reduce the mortality associated with fallback may include installation of extended-length screens (where feasible), extending the period during which the intake screens and juvenile bypass system are in operation, and modifying operations. Study plans, recommendations, and a schedule for accomplishing this action will be developed through the annual planning process.

Action 112: The Corps shall investigate ways to provide egress to adult fish that have fallen back into juvenile collection galleries and primary dewatering facilities at Ice Harbor and McNary dams. The Corps shall either install structural, or implement operational, remedies to minimize delay and injury of fish that fall back, as warranted.

Prespawn, summer-run steelhead are abundant near McNary Dam during the late fall and early winter months. Fallback through the juvenile bypass system at McNary Dam can exceed 50 steelhead per day before screen removal on December 15 (Paul Wagner, Washington Department of Fish and Wildlife, pers. comm.). These fish accumulate in the juvenile bypass system, and many are delayed for protracted periods. Timely and safe egress alternatives for these fish must be identified.

Action 113: The Corps shall investigate measures to reduce adult steelhead and salmon fallback and mortality through the Bonneville Dam spillway. A final report shall be submitted to NMFS stating the findings of these investigations and recommending corrective measures. Potential remedies shall be included in the annual planning process.

Keefer and Bjornn (1999) estimate, based on radiotelemetry, that ladder counts at Bonneville Dam are overcounted by 13.5 to 19.3% for spring/summer chinook salmon from 1996 through 1998, by 4.7% to 8.2% for steelhead from1996 through 1997, and by 12.6% for sockeye in 1997 when fallback and reascension are taken into account. Fallback rates at Bonneville Dam were 12 to 15% for spring/summer chinook (1996 to 1998), and 5 to 10% for steelhead (1996 to 1997). Assigning mortality associated with fallback to dam operations or behavior is difficult because some fish may have overshot and are returning to lower river tributaries. Bjornn et al. (1999) observed a fallback mortality of 8% for sockeye salmon at Bonneville Dam (a species with no spawning below Bonneville Dam). Keefer and Bjornn (1999) used radio-tagged fish known to have passed Bonneville Dam in 1996 to estimate survival to tributaries or the top of Priest Rapids Dam. Steelhead and spring/summer chinook salmon that did not fall back over Bonneville Dam had survival rates that were 3.8 to 5.2% higher than fish that did fall back (NMFS 2000e). Conceivably, corrective operations or facility changes which significantly reduce fallback at Bonneville Dam could increase the survival rate of spring/summer chinook to Lower Granite Dam by 0.7% [15% x 4.5% = 0.68%] and of steelhead by 0.5% [10% x 4.5% = 0.45%]. These estimates of potential survival increases are calculated by multiplying the fallback rate observed at Bonneville Dam in 1998 for spring/summer chinook, and for steelhead in 1997, times 4.5%, which is the average higher survival rate to Lower Granite Dam for adults that did not fall back at Bonneville Dam. Adult fallback through the Bonneville Dam spillway has been a long-standing concern. Further investigation is needed to determine factors affecting fallback and identify potential measures to reduce it.

Action 114: The Corps shall examine existing fish-ladder water temperature and adult radio-telemetry data to determine whether observed temperature differences in fishways adversely affect fish passage time and holding behavior. If non-uniform temperatures are found to cause delay, means for supplying cooler water to identified areas of warmer temperatures should be developed and implemented in coordination with the annual planning process.

Data collected by the Corps show that water temperatures at various sections of the John Day fishways differ from 1° to 4°C (34° to 39°F) at times. Effects of such differences on fish passage are unknown.

Action 115: The Corps and BPA shall conduct a comprehensive depth and temperature investigation to characterize direct mortality sources at an FCRPS project considered to have high unaccountable adult losses (either from counts and/or previous adult evaluations).

Previous radiotelemetry investigations have been two-dimensional and have attempted to characterize passage routes and timing of successfully passing fish. This study will also attempt to focus on those fish that do not successfully pass and determine whether a consistent source of mortality can be identified and corrected.

Action 116: The Corps shall investigate adult fish delay and fallback at ladder junction pools and implement remedies to reduce this problem, as warranted.

A large percentage of fish fall back from fishway junction pools at each FCRPS and other hydro projects studied to date. Cumulative delay and influence on prespawning mortality could be substantial. Modified hydraulic conditions and other possible remedies, coupled with behavior responses in these areas, may reduce this delay.

Action 117: The Corps shall evaluate adult count station facilities and rehabilitate where necessary at all projects to either minimize delay of adults or minimize counting difficulties that reduce count accuracy.

Some FCRPS hydro project fishway counting stations need design improvement to reduce delay. Cumulative delay and influence on prespawning mortality could be substantial. Rehabilitating counting stations could also improve the accuracy of adult fish counts.

Action 118: The Corps shall develop and implement a program to better assess and enumerate indirect prespawning mortality of adult upstream-migrating fish. Such mortality may be due to, or exacerbated by, passage through the FCRPS hydro projects. If measures are identified which will reduce the unaccountable adult loss rate and/or the prespawning mortality rate, the Corps shall implement these measures as warranted. The program should also enhance efforts to enumerate unaccountable losses associated with tributary turnoff, harvest, or other factors in FCRPS mainstem reservoirs and upstream of FCRPS projects.

Adult radiotelemetry has been used to estimate the survival of spring/summer chinook salmon from Ice Harbor Dam to the spawning ground or hatcheries. Bjornn et al. (1995) estimated that survival from Ice Harbor Dam to the spawning ground or hatcheries to be 54% in 1991 and 77% in 1993. In these same studies, survival from Ice Harbor Dam to Lower Granite Dam was estimated to be 81% in 1991 and 86% in 1993. Calculating the difference in these estimated survival rates from Ice Harbor Dam to Lower Granite Dam and Ice Harbor Dam to spawning ground/hatcheries implies theoretical adult loss from Lower Granite Dam to spawning ground/hatcheries of 27% (1991) and 9% (1993) [81% - 54% = 27%; 86% - 77% = 9%]. While further studies will be needed to resolve the accuracy and cause of these preliminary observations, the significance of this level of adult loss above Lower Granite Dam to the prospect of recovery cannot be overstated. Furthermore, mere arrival at the spawning ground does not guarantee spawning success. If spawning success is diminished during upstream passage through the FCRPS, these adult loss estimates are conservative.

The program called for in this action should include studies to assess the effects of upstream migration of adults through the hydrosystem (including the thermal environment through which they must migrate) on their overall fitness and spawning success, including energy budgets, ability to complete spawning behavior, and successful production of quality gametes. Currently, little work has been completed to assess the magnitude and breadth of prespawning mortality of adult migrants, especially upstream of the FCRPS hydrosystem. New methods of assessment should be evaluated, including the investigation of long-term PIT-tag retention in maturing salmonids. The investigations are expected to identify measures at FCRPS hydro projects, and possibly in tributaries, that will lead to reductions in prespawning mortality throughout the Columbia River basin.

Action 119: The Corps shall ensure that alterations to fish ladders and adult passage facilities to accommodate Pacific lamprey passage do not adversely affect salmonid passage timing and success.

Followup evaluations are needed as a precaution.

9.6.1.6.3 Adult Fishway Operating Criteria. The Corps' annual fish passage plan stipulates operating criteria for FCRPS hydro project adult fishways. Where this criterion is not satisfied, incremental adverse effects to adult migrants (such as delay) may occur. Actions to enhance compliance with fishway criteria include auxiliary water system assessments and upgrades. Other actions address the issue of inadequate fishway entrance weir submergence during low tailwater elevations.

Action 120: The Corps shall develop improved operations for adult fishway main entrances at FCRPS dams so that the best possible attraction conditions are provided for adult migrants, both at the four Columbia River hydro projects and the four lower Snake hydro projects (where reservoir elevations are held near MOP). The Corps shall report the findings of fishway entrance flow-balancing investigations in a report to NMFS by the end of 2001 and shall continue to work through FPOM to evaluate and implement, as warranted, structural changes to satisfy fish passage plan fishway entrance criteria.

Current Fish Passage Plan fishway entrance criteria cannot be satisfied at some entrances at many FCRPS hydro project fishways during low tailwater periods. Concurrently, some entrances pass appreciably more attraction flow than other entrances at the same project. The Corps should, on an interim basis, conduct hydraulic evaluations and make operational changes to increase attraction flows at entrances not presently meeting fishway criteria at all tailwaters during the adult passage season. The Corps should also continue to investigate various operations (such as closing floating orifice gates or other operational alternatives) to improve adult entrance and passage conditions.

9.6.1.6.4 Reliability Enhancement. FCRPS hydro project fishways must operate in the optimum manner during fish passage periods to minimize the risk of injury and mortality. Actions to increase reliability include fishway assessments to identify aging facilities (and components) in need of replacement or redesign, improved debris handling capability, and emergency backup auxiliary water capabilities (related to satisfying fishway entrance attraction water supply criteria).

Action 121: The Corps shall develop and maintain an auxiliary water-supply, emergency-parts inventory for all adult fishways where determined necessary, in coordination with NMFS.

Emergency auxiliary water supplies are needed to maintain fishways within optimum criteria for passage in the event of turbine, pump, electrical, debris management, or water-control system component failures.

Action 122: The Corps shall continue design development and, subsequently, construct an emergency auxiliary water supply system at The Dalles Dam's east ladder.

The Dalles adult fishways pass the second-highest number of adult fish of any FCRPS hydro project. With aging auxiliary water turbines, generators, and transformers, there is an increasing risk of faulty adult fishway performance during primary passage periods. Emergency backup auxiliary water is vital to attract fish into the fishways, if a primary fishwater turbine failure occurs.

Action 123: The Corps shall continue to investigate alternatives to dewater adult auxiliary water system floor diffusers for inspection at The Dalles adult fishway powerhouse collection channel. The Corps shall implement design and construction of needed changes, as warranted.

Leaking fishway entrance gates at The Dalles Dam make it impossible to dewater the powerhouse adult collection channel to inspect aging facilities such as add-in diffusers. Several years ago, numerous adult salmon passing through diffusers were killed. This action will minimize the chance of the recurrence of this problem and reduce leakage from the auxiliary water system.

Action 124: The Corps shall investigate methods to provide additional emergency auxiliary water to The Dalles Dam north fishway when the normal auxiliary water supply is interrupted.

If the existing Northern Wasco County PUD turbine at the north shore fishway has a prolonged outage, gravity auxiliary water would have to be provided for fishway attraction flow. The current rock conveyance channel is deteriorated and unstable. This additional water could also be used as a source of auxiliary water to supply the second fishway entrance if adult passage studies indicate the entrance is needed.

Action 125: The Corps shall develop and implement an automated monitoring and alarm system at appropriate FCRPS projects, as determined in the NMFS Regional Forum, to monitor changes in head differential remotely between the primary auxiliary water supply conduits/channels and the adult collection channels and to minimize diffuser damage due to excessive differentials. The Corps shall ensure that diffuser gratings for all auxiliary water supply systems are securely fastened. The Corps shall work through FPOM to develop a monitoring program for inspecting diffuser gratings and grating fasteners.

Implementation of this action would help avoid undetectable diffuser failures and potentially significant adult fish losses. In the interim, the Corps will work through the FPOM coordination team to develop early detection measures and include these in the annual Fish Passage Plan before the 2001 fish passage season.

9.6.1.6.5 Fishway System Assessments. Additional fishway assessments are needed to address, in a more comprehensive manner, fishway systems at some FCRPS hydro projects that have aging facilities or ongoing, unresolved problems. These assessments will lead to a well-defined list of corrective measures.

Action 126: The Corps shall initiate an investigation and prepare a report on the Bonneville First Powerhouse Bradford Island and Cascade Island adult fishway auxiliary water system by the end of 2001. In the report, the Corps shall identify measures that will improve or replace aging components, thereby enhancing current and long-term performance and reliability.

The need for design changes and improvements will be evaluated, particularly with respect to elevated dissolved gas levels in the auxiliary water supply systems. Report recommendations should be implemented, as warranted.

Action 127: The Corps shall continue its investigation of the Bonneville Second Powerhouse adult fishway auxiliary water system and shall identify measures to satisfactorily address emergency backup auxiliary water needs.

Bonneville Second Powerhouse adult auxiliary water facilities failed in 1997 during the peak of the adult fall chinook and steelhead migrations. This action is intended to ensure that this does not occur again.

Action 128: The Corps shall initiate an engineering study to evaluate existing limitations relating to its inability to satisfy fish passage plan operating criteria at the John Day Dam north shore ladder.

The study scope should also assess backup auxiliary water system (AWS) needs, reliability, or enhancement design improvements and upgrade options for the AWS system. The Corps will implement corrective measures as warranted.

Action 129: The Corps shall complete adult fishway auxiliary water supply evaluations at each lower Snake River hydro project and implement corrective measures as warranted.

The objective of this measure is to ensure compliance with fishway entrance criteria, optimize emergency auxiliary water backup provisions, and ensure long-term reliability.

9.6.1.7 Water Quality

9.6.1.7.1 Water Quality Strategy. In developing the biological opinion, NMFS, in coordination with EPA, USFS, and the Action Agencies (the Corps, BOR, and BPA), has considered the respective ecological objectives of the ESA and the Clean Water Act (CWA). In many instances, actions implemented for the conservation of ESA-listed species will also move toward attainment of water quality standards (e.g., reducing TDG and temperature). The overlap of statutory purpose is extensive; however, there are additional actions that are appropriate in a water quality plan, but that are nonessential for the survival and recovery of the listed species. Thus, such actions are not required components of the ESA RPA. Further, the water quality plan is likely to require lengthy study and implementation exceeding the duration of this biological opinion.

Appendix B charts a course for development of a water quality plan for the mainstem Columbia and Snake rivers to address CWA objectives. The scope of the plan is broader than the FCRPS and would include additional actions to improve mainstem water quality by reducing TDG and temperature. Some of these actions are expected to be undertaken by entities other than the Action Agencies. Although Appendix B is not itself a water quality plan, it suggests the procedure for development of a plan and identifies actions the plan would likely contain to move toward attainment of water quality standards for the FCRPS.

Appendix B refers to items in Section 9.6.1.7.2 as a nucleus of actions for the water quality plan. These actions are essential for the survival and recovery of the listed species and, thus, are required components of the RPA that also serve to improve water quality by reducing TDG and water temperature.

Appendix B also identifies actions for the FCRPS that further CWA objectives, but that are not also called for in the ESA RPA. These long-term actions for water quality improvements are listed in Table B-3 of the Appendix. These are studies to investigate additional measures to reduce TDG and temperature that may be considered for implementation. These studies are appropriate as ESA conservation measures that will require further ESA consultation when they are developed, analyzed, and proposed for implementation.

Currently, voluntary spill for fish passage occurs at dams up to the TDG level of 120% in the project tailrace, or 115% TDG in the next downstream project forebays, as allowed by special variances to state and Tribal water quality standards. However, spill for fish passage that results in exceedances of the 110% gas standard is considered an interim strategy in the sense that the long-term goal is to keep TDG levels within water quality standards.

Accordingly, the 1995 FCRPS Biological Opinion mandated initiation of the DGAS. This multi-year comprehensive study by the Corps investigated and extended understanding of gas absorption and reduction associated with spill at Columbia and Snake river hydro projects. It also investigated short- and long-term operational and structural gas abatement alternatives, which resulted in installation of spillway flow deflectors at both John Day and Ice Harbor spillways. These improvements increased project survival at both sites and improved water quality during both voluntary and involuntary spill periods. The DGAS also developed numerical models to fully investigate the hydrosystem response to structural and/or operational changes. One outcome of DGAS was that no structural action was identified that would reduce TDG levels to meet the state or Tribal water quality standards without threat of adverse effects to passing fish.

To assess the feasibility of reducing TDG to the 110% standard while still meeting the survival objectives of listed salmon, EPA, NMFS, USFWS, and the Federal Action Agencies commit to continued efforts to identify water quality improvement actions (see Appendix B). These efforts will lead to decisions on whether structural or operational changes exist that will allow FCRPS projects to achieve both fish passage and water quality objectives, or to encourage changes in non-Federal Columbia River basin projects that have a cumulative effect of reducing TDG levels systemwide. Information developed from these studies may also provide a basis for future decisions concerning beneficial use and water quality criteria revisions. Such decisions will result from a coordinated effort between EPA and NMFS and discussions with states, Tribes, and other interested parties. The EPA, NMFS, USFWS, and the Federal Action Agencies will continue to work toward implementing a combination of actions that benefit both fish survival and water quality.

Part of the decision-making process to evaluate the structural and operational changes necessary to meet the 110% TDG standard will be based on a review of the existing data collected since the release of the NMFS 1995 Biological Opinion (see Section 6.2.6.1.1 for a summary of the risk assessment for the spill program described in the NMFS 2000 Biological Opinion). GBT in juvenile salmonids is observed at all gas supersaturation levels, but the overall incidence and severity is low at FCRPS projects when managing fish passage spill to 115% to 120% TDG variance.

Without physical modifications to the dams beyond those that are presently under way, the long-term TDG goal cannot be attained between April and August at and between the eight mainstem FCRPS dams. This is a result of the need to rely on spill to safely pass juvenile salmon around those dams. A similar issue exists with Dworshak Dam, where, in some circumstances, spill is necessary to contribute to the attainment of spring and summer flow objectives for salmon migration and water temperature standards in the Clearwater and lower Snake rivers. In the near term, therefore, it will be necessary to conduct spill operations that cause exceedances of the 110% TDG gas standard. The Corps will take the actions necessary to implement the spill operation called for in this biological opinion, including spill in accordance with the special TDG conditions set forth below. NMFS will provide technical assistance, as necessary, to support the Corps' actions.

Special TDG Conditions for Juvenile Fish Passage. At the eight Columbia and Snake river mainstem hydro projects, and consistent with state and Tribal water quality variances, spill will be reduced as necessary when the average TDG concentration of the 12 highest hourly measurements per calendar day exceeds 115% of saturation at the forebay monitor of any Snake or lower Columbia river dam or at the Camas/Washougal station below Bonneville Dam. Spill will also be reduced when the 12-hour average TDG levels exceed 120% of saturation at the tailrace monitor at any Snake River or lower Columbia River dams or Dworshak Dam. Spill will also be reduced when instantaneous TDG levels exceed 125% of saturation for any 2 hours during the 12 highest hourly measurements per calendar day at any Snake, Clearwater, or lower Columbia river monitor.

The water quality plan in Appendix B includes the following basinwide goals for TDG and temperature. NMFS, EPA, and the Action Agencies commit to work toward these goals. They recognize, however, that reaching the goals may take more time than the duration of this biological opinion and that exceedances may, nevertheless, occur.

Total Dissolved Gas Goal. The long-term TDG goal (10 to 15 years) is to reach the 110% TDG standard in all critical habitat in the Columbia and Snake River basins while taking actions to recover listed species in the basins. For anadromous fish, achieving the goal would mean fish passage survival levels are consistent with the performance standards for the mainstem projects.

This goal is intended to guide operating and capital improvement decisions relating to TDG created during periods of spill. A systemwide approach is needed to address gas generated at mainstem projects where fish are present and at upstream facilities (i.e., outside the current range of listed salmon) in both the U.S. and Canada, the five PUD dams on the Columbia River between the Snake River and Chief Joseph Dam, and the Hells Canyon Complex on the Snake River. Some exceptions are noted in the ability to meet the state and Tribal TDG standard.

Water Temperature Goal. The long-term goal for water temperature is standard attainment in all critical habitat in the Columbia and Snake River basins. In the mainstem Columbia and Snake rivers, attainment of the temperature standard is very complex, due to a number of interrelated factors that affect water temperatures at certain times of the year and to the limited ability to alter water temperature in the mainstem. In the tributaries, attainment of the temperature standard is also complex, due to many of these same factors and the long time needed to realize the temperature benefits of remedial actions (such as riparian restoration). Therefore, in the near term, working with the state and/or Tribe with relevant regulatory authority, the interim goal is to move toward attaining the standard. Establishing TMDLs is expected to significantly promote progress toward the interim goal.

To ensure progress toward the long-term goals, the Corps, BOR, and BPA will also work with NMFS, USFWS, EPA, the Columbia River Tribes, and the states of Washington, Oregon, Idaho, and Montana through an adaptive management process as a part of the water quality plan described in Appendix B.

Perhaps none of the ongoing forums and/or water quality protection activities will provide the organizational structure desired to fully integrate the activities of the water quality plan as described in Appendix B. Therefore, final development and implementation of the water quality plan could be accomplished through reformulation of the Water Quality Team, consisting of senior policy analysts and supported by technical staff from Federal agencies, states, Tribes, and non-Federal entities.

9.6.1.7.2 Current and Near-term Actions and Studies

Total Dissolved Gas Measures

Action 130: The Corps shall complete its DGAS by April 2001. The results of this study will be used to guide future studies and decisions about implementation of some long-term structural measures to reduce TDG.

The DGAS was initiated in 1994 to examine potential methods to reduce TDG produced by spillway operations at the Corps' eight mainstem Snake River and Columbia River hydropower dams. The feasibility-level DGAS report is expected to be completed in spring 2001. The findings from this study have to be examined and discussed with interested parties in the region to guide future studies before making long-term implementation decisions about gas abatement alternatives.

Action 131: The Action Agencies shall monitor the effects of TDG. This annual program shall include physical and biological monitoring and shall be developed and implemented in consultation with the Water Quality Team and the Mid-Columbia PUDs' monitoring programs.

At a minimum, the physical monitoring components of this plan should include placement of physical TDG monitors in the tailraces and forebays of all lower Snake River and lower Columbia River dams, and daily recording of TDG data on the CROHMS database. This program should also include QA/QC components, including redundant and backup monitors at as many locations as the Water Quality Team determines necessary, calibration of monitoring equipment at least every 2 weeks, enough funding for spot-checking monitoring equipment during the fish passage season (number determined preseason by the Water Quality Team), an error checking, correcting, and recording function for CROHMS data, and daily data reporting. The QA/QC components should be reviewed annually and modified as improved information and techniques become available. The annual review should be conducted by the Action Agencies in coordination with the Water Quality Team.

At a minimum, the biological monitoring components will include smolt monitoring at selected smolt monitoring locations, adult monitoring at Bonneville and Lower Granite dams, and daily data collection and reporting.

Action 132: The Action Agencies shall develop a plan to conduct a systematic review and evaluation of the TDG fixed monitoring stations in the forebays of all the mainstem Columbia and Snake river dams (including the Camas/Washougal monitor). The evaluation plan shall be developed by February 2001 and included as part of the first annual water quality improvement plan. The Action Agencies shall conduct the evaluation and make changes in the location of fixed monitoring sites, as warranted, and in coordination with the Water Quality Team. It should be possible to make some modifications by the start of the 2001 spill season.

In past years, TDG monitoring in tailraces at mainstem dams produced variable results associated with differences in dam operations. Operational differences caused the proportion of spill and turbine-discharged water to change at measuring sites. This problem can be substantial and often causes unreliable extrapolation of TDG levels to downstream locations where spill and turbine flows are fully mixed. For this reason, TDG measurements in both forebays and tailraces have been monitored as part of the NMFS spill program. Forebay TDG monitors typically are located on the pier noses and other portions of hydro projects near turbine intakes or spillways. The tailrace stations, however, are located at various distances downstream from the hydro projects where spillway and powerhouse flows are mixed. One obvious deviation from the normal forebay monitoring location is the Camas/Washougal site. This site was chosen as a surrogate forebay monitor location for the river reach below Bonneville Dam because available data indicated that spill and powerhouse flows were normally well mixed at this point in the river.

In-season management of biological opinion spill to improve juvenile fish survival relies on the physical TDG and the biological GBT monitoring programs. Based on comments received on the draft opinion and a recent Corps review of possible biases in TDG monitoring data from TDG fixed forebay monitors at dams on the mainstem Columbia and Snake rivers, NMFS believes some sampling locations may have to be altered to provide a more representative measure of TDG in the water mass passing through the dams.

Action 133: As part of DGAS, the Corps shall complete development of a TDG model to be used as a river operations management tool by spring 2001. Once a model is developed, the applications and results shall be coordinated through the Water Quality Team. The Corps shall coordinate the systemwide management applications of gas abatement model studies with the annual planning process, the Transboundary Gas Group, the Mid-Columbia Public Utilities, and other interested parties.

TDG, caused by large volumes of water spilling over dams, can result in injury or mortality of juvenile salmonids. Since the 1960s, increased hydraulic capacity at powerhouses of mainstem projects, increased water storage, and structural modification to spillways have substantially reduced this problem. High levels of dissolved gas have, however, been measured under some river conditions even in recent years, such as during periods of involuntary spill. Development and continued refinement of a systemwide TDG model would assist with in-season management of involuntary spill.

Action 134: The Corps shall continue the spillway deflector optimization program at each FCRPS project and implement it, as warranted. The Corps and BPA shall conduct physical and biological evaluations to ensure optimum gas abatement and fish passage conditions. Implementation decisions will be based on the effect of spill duration and volume on TDG, spillway effectiveness, spill efficiency, forebay residence time, and total project and system survival of juvenile salmon and steelhead passing FCRPS dams.

The spillway deflector optimization program shall have the following objectives:

- Increase juvenile fish passage survival at FCRPS projects by increasing the allowable spill discharge up to the TDG special condition gas cap level during voluntary spill periods (as defined by the NMFS annual spill program in Section 9.6.1.4.4).

- Decrease TDG levels during both voluntary and involuntary spill periods.

- Considering both juvenile and adult fish passage criteria, develop spill patterns that improve juvenile survival, reduce delay of juvenile salmon in forebays, optimize juvenile egress from tailraces, and provide good adult passage conditions downstream of fish ladder entrances.

Action 135: The Corps shall include evaluations of divider walls at each FCRPS project in the spillway deflector optimization program. Design development and construction of divider walls would begin only after coordination within the annual planning process, and only if warranted.

Design development of divider walls is an option under consideration to potentially reduce entrainment of powerhouse flow into spillway flow. The degree to which powerhouse flow in the tailrace mixes laterally with spillway flow is an unresolved issue. Specifically, the extent to which powerhouse flow TDG levels are increased or decreased in the tailrace may be affected by mixing with water that has passed through the spillway. Additional investigation is required to increase understanding of this issue. Optimum deflector design development will include a full investigation of powerhouse flow entrainment with spillway flow and TDG uptake downstream of each project. Construction at an FCRPS project will be included in the deflector optimization program, if warranted, for the purpose of attaining water quality and fish survival benefits.

Action 136: The Corps shall continue to develop and construct spillway deflectors at Chief Joseph Dam by 2004 to minimize TDG levels associated with system spill.

To the extent feasible, the Corps, BOR, and BPA will treat Grand Coulee and Chief Joseph dams as a composite project to reduce the incidence of spill and TDG below Grand Coulee and other system projects by spilling proportionately more at Chief Joseph and shifting electrical load to Grand Coulee Dam.

Action 137: The Corps shall investigate TDG abatement options at Libby Dam, including the installation of spillway deflectors and/or additional turbine units. The Corps shall construct gas abatement improvements at Libby on the Kootenai River, as warranted, to reduce TDG levels below the project.

Through the use of numerical TDG modeling, the Corps should assess projected gas abatement benefits at Libby Dam on a site-specific and systemwide basis to improve the probability of refill and, if spill occurs, to avoid TDG levels above state water quality standards.

Action 138: The Corps shall continue to investigate RSWs, in conjunction with extended spillway deflectors, as a means of optimizing safe spillway passage of adult steelhead kelts and juvenile migrants.

While these prototype RSW evaluations continue, they have the potential to incrementally reduce both spill discharge and TDG levels downstream. Thus, development of RSWs (and other surface bypass concepts) have the potential to integrate implementation of actions to meet both ESA and CWA requirements. See also Section 9.6.1.4.5, Juvenile Fish Passage Studies.

Action 139: The Corps shall investigate TDG abatement options at Dworshak Dam and implement options, as warranted, in coordination with the annual planning process.

Implementation of TDG abatement measures at Dworshak has the potential to improve water quality when project discharges exceed current turbine capacity. Options may include increasing the number of turbine units at the powerhouse.

Action 140: The Corps shall design the spillway Number 1 (end bay) deflector at John Day Dam, and implement as warranted, in coordination with the annual planning process.

Absence of a spillway deflector at spill bay Number 1 results in fixed monitor station TDG readings that are unrepresentative relative to the entire spillway tailrace.

<u>Water Temperature Measures.</u> The Action Agencies, in coordination with EPA, NMFS, and USFWS, intend to abate or offset temperature effects associated with FCRPS operations and assess the feasibility of reducing temperature in ways beneficial to fish, based on the actions identified below.

Summer operations for temperature control in the Snake River are included in Section 9.6.1.2.3 under Dworshak Dam operations.

Modifications to make Dworshak NFH water supply rearing operations independent of Dworshak Reservoir temperature control releases in the summer are included in Section 9.6.1.2.6 under Measures to Evaluate and Adjust the Amount of Water Available to Support Flow Objectives.

Evaluations of fish ladder water temperature and adult passage data are included in the adult passage studies discussion in Section 9.6.1.6.2.

Action 141: The Action Agencies shall evaluate juvenile fish condition due to disease in relation to high temperature impacts during critical migration periods. This evaluation should include monitoring summer migrants at lower Columbia and lower Snake river dams to clarify the possible link between temperature and fish disease and mortality. This information will be used to assess the long-term impacts of water temperature on juvenile fish survival.

High water temperatures have been linked to stress and disease in fish. It is essential to acquire a better base of information to understand the sources of fish disease and mortality at the lower Columbia and lower Snake river dams during critical fish migration periods and high temperature events. This information could be used to better understand the effect of high water temperature on juvenile fish survival.

Action 142: The Corps shall work through the regional forum process to identify and implement measures to address juvenile fish mortality associated with high summer temperatures at McNary Dam. As a starting point, the Corps shall assemble and analyze the temperature data that have been recorded in the McNary forebay, collection channel, and juvenile facilities. The Corps shall examine relationships among juvenile mortality, temperatures, river flow rates, and unit operations in detail. The Corps shall investigate the feasibility of developing a hydrothermal computational fluid dynamics model of the McNary forebay to evaluate the potential to determine optimal powerhouse operations or structural modifications for minimizing thermal stress of juvenile salmon collected in the summer and to conduct a modeling program, if warranted.

Thermal profile data have been routinely collected at McNary Dam for more than a decade. These data formed the basis for special project operations, such as north powerhouse loading operations during the summer-warm-water temperature period. The 1995 NMFS Biological Opinion required the Action Agencies to take measures to reduce the potential for reoccurrence of the 1994 thermal-related mortality observed at McNary Dam. Coutant (1999) suggested that the cause of the observed acute mortalities was a cumulative thermal dose of exposure to high-temperature water received over several days (NMFS 2000c).

Action 143: By June 30, 2001, the Action Agencies shall develop and coordinate with NMFS and EPA on a plan to model the water temperature effects of alternative Snake River operations. The modeling plan shall include a temperature data collection strategy developed in consultation with EPA, NMFS, and state and Tribal water quality agencies. The data collection strategy shall be sufficient to develop and operate the model and to document the effects of project operations.

The modeling plan should focus on water temperatures in the Snake River from Hells Canyon Dam and from Dworshak Dam on the North Fork of the Clearwater River to Bonneville Dam on the Columbia River. Predictive nodes should be located at the near-dam forebays and tailraces of each project. Both one- and multi-dimensional models (due to reservoir stratification) may be needed to fully define expected temperature conditions within the reach. The models should be developed to function both as a pre-season planning tool and to provide predicted outcomes of immediate operations in real time to assist in the in-season water management decision process.

Existing water temperature and meteorological data may be inadequate for this purpose. Existing data and statistical tools will be used to identify locations where additional or improved data collection, in terms of precision, accuracy and frequency, would be most beneficial.

9.6.1.8 Strategy to Improve Fish Facility Operations and Maintenance

The strategy to improve fish facility operations and maintenance addresses the need for adequate O&M budget and funding commitments by the Corps and BPA, coupled with the resource capability to undertake and implement needed O&M actions. The overall goal is to ensure that new and existing fish passage facilities perform at their designed level to increase both juvenile and adult fish survival. An improved O&M program should accomplish the following:

- Meet the increasing O&M needs of aging fish passage and spillway facilities.

- Incorporate new O&M requirements as new fish passage facilities are installed.

- Accommodate expanding annual budget requirements associated with operational changes and research needs.

- Implement preventive maintenance programs for fish passage facilities to assure long-term reliability.

9.6.1.8.1 Fish Passage Plan Development and Implementation. The Corps should continue to annually update the fish passage plan in coordination with NMFS and through the process established by FPOM. Comments developed by NMFS on the draft fish passage plan shall be reconciled by the Corps in writing to NMFS' satisfaction or implemented before release of the final fish passage plan. The Corps should continue to provide weekly and annual reports regarding implementation of the fish passage plan to NMFS.

All planned special facility operation activities that cause any facility to be out of compliance with the operations and criteria described in the main text of the fish passage plan (and expected to result in the take of listed salmon stocks) must be adequately coordinated with NMFS at least 1 month before the anticipated action date. Identifying special project operations in the fish passage plan does not mean that the action has undergone the requirements of an ESA Section 7 consultation. The effects of special operations on listed fish are usually not adequately specified in the fish passage plan, and NMFS requires further essential information, including a brief summary of the action, location, anticipated date and time, analysis of potential effect on listed salmon stocks, and potential alternative actions.

The Corps should work through the FPOM to identify needs and priorities in making hourly individual turbine unit and spill bay operation data available on its Web site, real time, during the juvenile migration season. NMFS needs these data to monitor compliance with operating criteria in the annual fish passage plan (e.g., unit operating priorities and spill patterns), as well as for agreed-upon special project operations for research or maintenance.

9.6.1.8.2 Actions to Improve Operation and Maintenance of Passage Facilities

Action 144: The Corps, in coordination with the Regional Forum, shall maintain juvenile and adult fish facilities within identified criteria and operate FCRPS projects within operational guidelines contained in the Corps' Fish Passage Plan. The Corps shall coordinate with NMFS on the development of these criteria and operational guidelines before the start of each fish passage season (generally February 1).

Insufficient ladder entrance water depth and insufficient entrance attraction velocity are factors that negatively affect adult fish passage (Bell 1991). Maintaining fishways within optimum criteria for passage is likely to reduce dam passage delays for migrating salmon. Monitoring adult fishways frequently and improving the maintenance and repair of fishway components such as pumps, gear boxes, diffuser valves, and entrance gate controls are expected to improve system operational reliability.

The following are examples of Fish Passage Plan issues that have to be resolved before the 2001 fish passage season:

- The frequency of daily inspections for all fish passage facilities throughout the passage season

- A schedule for completion of identified maintenance needs and repairs

- A cleaning schedule and frequency table of juvenile bypass collection channel orifices in operating units during the high debris months (April through June)

- A schedule for closing floating orifices (which are to be closed before the main entrances) in adult fishways during emergency auxiliary water supply outages

Upgrading existing adult fish passage facilities will also aid the monitoring effort and contribute to maintenance of optimum criteria. The upgrade should include the following:

- Automation of control systems

- Placement of staff gauges (for determining water elevations) in areas that are accessible for both cleaning and reading

- Providing velocity meters in areas of known low velocity in the collection channels

Action 145: The Corps shall develop and implement preventative maintenance programs for fish passage facilities that ensure long-term reliability, thereby minimizing repair costs.

Action 146: The Corps shall address debris-handling needs and continue to assess more efficient and effective debris-handling techniques to ensure that the performance of both new and old fish passage facilities will not be compromised.

This effort should include the investigation of debris shear booms at all FCRPS Corps projects that pass listed fish. Design and construction of appropriate facilities should be undertaken as warranted. Shear booms keep as much debris as possible from accumulating at the upstream powerhouse face, where the debris increases fish injury and mortality and requires more labor-intensive handling and removal. These investigations will include assessment of predator cover and potential guidance of juvenile salmonids away from fish passage facilities as a result of the boom structure.

9.6.1.9 Advance Planning for Possible Additional Actions

Action 147: As a contingency plan, the Corps (in cooperation with other Federal agencies) shall develop a project management plan to reevaluate more intensive hydropower-related actions (including breaching) for the four lower Snake River dams. The project management plan will identify the scope, schedule, costs, tasks, products, and responsibilities for the reevaluation study. The study should assess all significant changed conditions to the Lower Snake River Feasibility Report and Environmental Impact Statement (Corps 1999c). The project management plan should be consistent with direction from Congress, Corps authorities, and other legal requirements. The completed project management plan should be coordinated with the appropriate regional interests. The project management plan should include, but not be limited to, plans to mitigate disproportionate impacts to communities, industries, and Tribes, detailed water and air quality effects, implementation plans, and a complete public involvement program. The decision to start the reevaluation study should result from the NMFS check-in process in Section 9.5. The Corps will request funding or reprogramming to complete the project management plan within 1 year after NMFS' issuance of a check-in report indicating the need to seek additional authority. The study should result in a general reevaluation report and supplemental environmental impact statement, which would be used to seek authorization and/or appropriations to implement, recommended action(s), if needed. The general reevaluation report/ supplemental environmental impact statement will require approximately 2 years to complete.

Action 148: The Corps shall conduct detailed engineering and design work for improvements recommended in the general reevaluation report and supplemental environmental impact statement described in the preceding action. The Corps shall seek funding to allow initiation of the engineering and design work to occur immediately upon completion of the final general reevaluation report. The engineering and design work shall include only those activities on (or near) the implementation schedule critical path for the recommended actions, up to the award of the first construction contract. For a dam breach recommendation, the critical path activities shall include turbine physical modeling (for use as low level outlets), rock source explorations for embankment erosion protection (riprap), and hydraulic (physical) modeling for the embankment removal and channelization. Tentative milestones for the general reevaluation report/EIS and engineering and design work are as follows, based on the check-in process identified in Section 9.5:

Year 1	-	Complete project management plan
	-	Project management plan regional coordination
Year 2	-	Initiate general reevaluation report/supplemental environmental impact statement
Year 3	-	Complete final general reevaluation report/supplemental environmental impact statement
	-	Initiate detailed engineering and design
	-	Issue approval of general reevaluation report/supplemental environmental impact statement
	-	Seek authorization and appropriations

Although breaching is not essential to implementation of the initial actions called for in the RPA, which constitute a non-breach approach, the RPA requires that the Action Agencies prepare for the possibility that breaching or other hydropower actions could become necessary. These actions will reduce the time needed to seek congressional authorization, if necessary, and thus reduce the time needed for possible implementation.

It is unacceptable to recommend a non-breaching alternative in the Lower Snake River feasibility report/environmental impact statement with a future contingency for breaching. Future decisions (whether they are made in 5 or 10 years) must be made with the best available information on the effects on all resources and users. Therefore, future decisions will require some reevaluation and NEPA compliance. In addition, any reevaluation of breaching must also consider all possible alternative actions as well.

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9.6.2 Habitat Actions

The habitat strategy is intended to accelerate efforts to improve survival in priority areas in the short term, while laying a foundation for long-term strategies through subbasin and watershed assessment and planning.

In the short term, Federal agencies commit in the Basinwide Recovery Strategy to focus immediate attention on priority subbasins, i.e., those with potential for significant improvement in anadromous fish productive capacity as a result of habitat restoration. The Basinwide Recovery Strategy identifies these short-term actions, timelines, and responsible Federal agencies. This biological opinion identifies the Action Agencies' contribution to the Basinwide Recovery Strategy. Where costs are stated in this biological opinion, they are estimates meant to help define the scale and pace of the action, not specific amounts the Action Agencies must actually spend to comply.

Over the long term, the habitat strategy has three overarching objectives: 1) protect existing high quality habitat, 2) restore degraded habitats on a priority basis and connect them to other functioning habitats, and 3) prevent further degradation of tributary and estuary habitats and water quality.

9.6.2.1 Actions Related to Tributary Habitat

When related to the basic habitat needs of listed anadromous fish, tributary habitat efforts have the following objectives:

- Water quantity—increase tributary water flow to improve fish spawning, rearing, and migration.
- Water quality—comply with water quality standards, first in spawning and rearing areas, then in migratory corridors.
- Passage and diversion improvements—address in-stream obstructions and diversions that interfere with or harm listed species.
- Watershed health—manage both riparian and upland habitat, consistent with the needs of the species.
- Mainstem habitat—improve mainstem habitat on an experimental basis and evaluate the results.
- Estuary improvement—improve and restore habitat conditions in the Columbia River estuary.

Action 149: BOR shall initiate programs in three priority subbasins (identified in the Basinwide Recovery Strategy) per year over 5 years, in coordination with NMFS, FWS, the states and others, to address all flow, passage, and screening problems in each subbasin over 10 years. The Corps shall implement demonstration projects to improve habitat in subbasins where water-diversion-related problems could cause take of listed species. Under the NWPPC program, BPA addresses passage, screening, and flow problems, where they are not the responsibility of others. BPA expects to expand on these measures in coordination with the NWPPC process to complement BOR actions described in the action above.

The Federal agencies have identified priority subbasins where addressing flow, passage, and screening problems could produce short-term benefits. This action initiates immediate work in three such subbasins per year, beginning in the first year with the Lemhi, Upper John Day, and Methow subbasins. Subbasins to be addressed in subsequent years will be determined in the annual and 5-year implementation plans. NMFS will consider the level of risk to individual ESUs and spawning aggregations in the establishment of priorities for subsequent years. At the end of 5 years, work will be underway in at least 15 subbasins. The objective of this action is to restore flows needed to avoid jeopardy to listed species, screen all diversions, and resolve all passage obstructions within 10 years of initiating work in each subbasin. BOR is the lead agency for these initiatives and will facilitate their implementation. In addition, recognizing the critical importance of starting this work quickly, BPA will expand on measures under the NWPPC program to complement BOR's action. To support this work, NMFS will supply BOR with passage and screening criteria and one or more methodologies for determining instream flows that will satisfy ESA requirements. The Corps will use available funding and authorities to implement restoration actions in priority subbasins and in areas such as the Walla Walla basin, where water-diversion-related issues could cause take of listed species.

Action 150: In subbasins with listed salmon and steelhead, BPA shall fund protection of currently productive non-Federal habitat, especially if at risk of being degraded, in accordance with criteria and priorities BPA and NMFS will develop by June 1, 2001.

This opinion puts high priority on protecting habitat that is currently productive, especially if it represents a habitat type that already limits an ESU's productivity (e.g., summer rearing or over-wintering habitat). BPA should protect these habitats through conservation easements, acquisitions, or other means, working with non-profit land conservation organizations and others.

Action 151: BPA shall, in coordination with NMFS, experiment with innovative ways to increase tributary flows by, for example, establishing a water brokerage. BPA will begin these experiments as soon as possible and submit a report evaluating their efficacy at the end of 5 years.

Tributary flow problems are widespread. It is unclear whether and how solutions can be implemented through existing laws and administrative processes. To test new approaches to this problem, Bonneville will conduct experiments such as organizing a non-profit water brokerage to demonstrate transactional strategies for securing tributary flow—and, where feasible, addressing water quality—in streams with significant non-Federal diversions. The project would develop a competitive process to supply water to increase flows and water quality at the lowest cost. Expectations for this project are as follows:

- In year 1, BPA will fund development of a methodology acceptable to NMFS for ascertaining instream flows that meet ESA requirements, establish a new non-profit entity or contract with a non-profit entity(ies) to carry out this project, require the non-profit entity(ies) to develop an operations plan, and initiate a trial round of water solicitations.

- In years 2 through 5, the non-profit entity should be fully operational, processing water solicitations and completing transactions according to the operations plan, and should explore possibilities for accomplishing water and other habitat objectives together.

An objective third-party evaluator will review the program after 5 years, and a decision will be made whether to continue it. The estimated BPA expenditure for this project is $2.5 million in the first year, $5 million in the second year, and $5 to $10 million per year thereafter, as justified by prospective transactions. NMFS and BPA should make joint decisions regarding funding beyond the $5 million-per-year base in years 2 to 5, in cooperation with the NWPPC's prioritization process. Recognizing recent amendments to the Columbia River Basin Fish and Wildlife Program regarding a land and water trust fund, BPA and NMFS will explore the possibility of integrating this action item with such a trust fund.

Action 152: The Action Agencies shall coordinate their efforts and support offsite habitat enhancement measures undertaken by other Federal agencies, states, Tribes, and local governments by the following:

- Supporting development of state or Tribal 303(d) lists and TMDLs by sharing water quality and biological monitoring information, project reports and data from existing programs, and subbasin or watershed assessment products.
- Participating, as appropriate, in TMDL coordination or consultation meetings or work groups.
- Using or building on existing data management structures, so all agencies will share water quality and habitat, data, databases, data management, and quality assurance.
- Participating in the NWPPC's Provincial Review meetings and Subbasin Assessment and Planning efforts, including work groups.
- Sharing technical expertise and training with Federal, state, Tribal, regional, and local entities (such as watershed councils or private landowners).
- Leveraging funding resources through cooperative projects, agreements and policy development (e.g., cooperation on a whole-river temperature or water quality monitoring or modeling project).

This effort would include funding implementation measures recommended in EPA- and state-approved tributary TMDLs that NMFS determines are essential to avoid jeopardy to the listed stocks.

Measures implemented by the Action Agencies to improve habitat can complement efforts by other Federal agencies, states, Tribes, and regional or local entities such as watershed councils. Similarly, endeavors by other Federal agencies, states, and Tribes can complement those of the Action Agencies. As an example of the former, information garnered from the studies and other measures implemented consistent with this opinion can be helpful to states and Tribes as they prepare 303(d) lists and TMDLs for tributaries in the Columbia River basin. Information obtained by states and Tribes as they develop TMDLs can be helpful to the Action Agencies as they study ways to improve water quality for fish through subbasin assessment and planning under the NWPPC's amended fish and wildlife program. More specifically, temperature monitoring stations installed by one entity could benefit all. Therefore, when Action Agency measures to improve habitat will complement efforts by states, Tribes, and local governments, and vice versa, the Action Agencies (as part of the subbasin planning process or management or implementation of the NWPPC's fish and wildlife program) shall consult with these entities to discern how their respective water quality efforts can complement each other and avoid duplication. Cost-sharing may be possible. The Action Agencies shall then implement measures as approved through applicable planning processes.

These actions are intended to improve Columbia River basin water quality, with the goal of being consistent with or complementing the NWPPC amended fish and wildlife program, the Clean Water Action Plan, the Unified Federal Policy for a Watershed Approach to Federal Land and Resource Management, the states of Washington and Oregon's Lower Columbia River Estuary Program Comprehensive Conservation and Management Plan, the Inter-Governmental Task Force for Monitoring principles, and state and local watershed planning efforts.

Action 153: BPA shall, working with agricultural incentive programs such as the Conservation Reserve Enhancement Program, negotiate and fund long-term protection for 100 miles of riparian buffers per year in accordance with criteria BPA and NMFS will develop by June 1, 2001.

Under certain farm incentive programs, farmers and ranchers may enter into 10- to 15-year contracts to plant riparian buffers or restore wetlands on streams that provide habitat for listed salmonids. Experience with similar programs suggests that these buffers can be made permanent, or at least long-term, by adding an increment to the contract price. Securing such protection adds value in terms of riparian corridor restoration and, where recognized by state law, instream flow restoration.

Action 154: BPA shall work with the NWPPC to ensure development and updating of subbasin assessments and plans; match state and local funding for coordinated development of watershed assessments and plans; and help fund technical support for subbasin and watershed plan implementation from 2001 to 2006. Planning for priority subbasins should be completed by the 2003 check-in. The action agencies will work with other Federal agencies to ensure that subbasin and watershed assessments and plans are coordinated across non-Federal and Federal land ownerships and programs.

In the long term, habitat recovery and watershed restoration for non-Federal public, Tribal, and private lands require state and local stewardship. An overall framework for this stewardship can be created through subbasin and watershed plans and related recovery plans which establish goals, objectives, and priority actions that are coordinated across Federal and non-Federal ownerships and programs. BPA is funding the bulk of NWPPC's subbasin assessments and plans. These plans will provide an important context for classifying and prioritizing watersheds for protection and restoration. They will also provide the foundation for ESA recovery planning which will be conducted in a similar time frame. Several watershed scale efforts are underway. The Federal land management agencies are conducting watershed assessments in most watersheds with significant Federal land ownership. State and local governments are conducting assessments and developing plans at the watershed scale to meet ESA regulations, CWA TMDLs, and other needs. In its final 4(d) rule (July 10, 2000), NMFS committed to working with states to develop guidelines for watershed assessments and plans. As these steps are completed, priorities, targets, and schedules will emerge, and priorities can be adjusted. As described in the Basinwide Recovery Strategy, all the Federal agencies are committed to coordinating assessment, planning, and priorities across non-Federal and Federal land ownerships and programs. As subbasin and watershed plans are completed, the Action Agencies should identify habitat actions in annual and 5-year implementation plans and implement them.

Action 155: BPA, working with BOR, the Corps, EPA, and USGS, shall develop a program to 1) identify mainstem habitat sampling reaches, survey conditions, describe cause-and-effect relationships, and identify research needs; 2) develop improvement plans for all mainstem reaches; and 3) initiate improvements in three mainstem reaches. Results shall be reported annually.

Large-scale water development over the last 65 years has inundated and significantly degraded mainstem habitat. Populations such as fall chinook that were once highly productive spawned in the mainstem and in the lower reaches of major tributaries. Studies in other river systems in the Northwest indicate that mainstem habitat improvements can result in greater population and habitat diversity, complexity, and productivity. However, no systematic assessment of habitat modifications from dam construction has been done, nor have potential restoration sites and specific benefits to salmon and steelhead been identified. BPA, working with the Corps, will take immediate steps to begin to address these uncertainties by collecting baseline data, improving mainstem reaches in ways that mimic the range and diversity of historic habitat conditions as much as possible, and monitoring and evaluating the results. Results will be reported annually. After 5 years, NMFS and the Action Agencies, in consultation with NWPPC and others, will determine whether to make changes in this program.

Action 156: The Action Agencies and NMFS shall study the feasibility (including both biological benefits and ecological risks) of habitat modification to improve spawning conditions for chum salmon in the Ives Island area.

The objectives of the study will be to determine whether it would be beneficial to increase the frequency of access to spawning habitat or the areal extent of spawning habitat by means other than flow augmentation. The feasibility study will evaluate actions to alter the hydraulic control points that limit flow in the Ives Island area to provide the same areal extent and quality of sustainable spawning habitat (including characteristics such as upwelling through the gravels currently present at the site) at lower levels of Bonneville discharge; reconstruct spawning channels to increase the extent of habitat available at a given level of Bonneville discharge; and maintain hydraulic connections between tributary habitats and the mainstem Columbia River to allow entry for adults and emergence channels for juveniles.

Action 157: BPA shall fund actions to improve and restore tributary and mainstem habitat for CR chum salmon in the reach between The Dalles Dam and the mouth of the Columbia River.

The purpose of this action is to compensate for effects of FCRPS water management in the Ives Island area, which appreciably diminish the value of critical spawning habitat for the survival and recovery of CR chum salmon. The FCRPS has been a relatively important factor for decline of this ESU. Bonneville and The Dalles dams limit access to potential spawning habitat further upstream and Bonneville Reservoir drowned known historical habitat in Bonneville pool. Spawning is currently known in only two areas: the Grays River system in the Columbia River estuary and the Hardy/Hamilton creeks/Ives Island complex, downstream of Bonneville Dam.

Although most of the existing subbasin populations and the ESU as a whole are on a slightly positive growth trajectory (ESU-level lambda = 1.035), RPA water management operations will continue to limit the areal extent of spawning habitat in Bonneville pool and the Ives Island complex in most water years. Therefore, BPA will 1) fund surveys of existing and potential tributary and mainstem habitat in the Columbia River between The Dalles Dam and the mouth of the Columbia River for suitable protection and restoration projects, 2) develop and implement an effective habitat improvement plan, 3) protect, via purchase, easement, or other means, existing or potential spawning habitat in this reach and adjacent tributaries (i.e., protect, restore, and/or create potentially productive spawning areas). The overall goal of this effort will be to ensure the survival and recovery of CR chum salmon by ensuring the availability of diverse, productive spawning habitats over a wide range of water years.

9.6.2.2 Actions Related to Estuarine Habitat

Estuarine protection and restoration must play vital roles in rebuilding the productivity of listed salmon and steelhead throughout the Columbia River basin. The states of Oregon and Washington, with congressional authorization under the CWA, have developed a Comprehensive

Conservation and Management Plan through the Lower Columbia River Estuary Program (LCREP). The Federal agencies strongly support the actions of this plan that contribute to salmon recovery and seek to expand on them.

The following action items call on the Action Agencies, primarily the Corps and BPA, to play an important role in estuary restoration efforts. The Corps is meant to play a lead role, with BPA primarily providing cost-share funding. The Corps and BPA actions are not meant to hinge on LCREP approval, but they are meant to be fully coordinated with the LCREP.

Action 158: During 2001, the Corps and BPA shall seek funding and develop an action plan to rapidly inventory estuarine habitat, model physical and biological features of the historical lower river and estuary, identify limiting biological and physical factors in the estuary, identify impacts of the FCRPS system on habitat and listed salmon in the estuary relative to other factors, and develop criteria for estuarine habitat restoration.

A good deal is unknown about the ecology of the Columbia River estuary insofar as it affects listed species. It is important to develop a better understanding of historic salmon rearing patterns in the estuary; historic changes in the distribution, amounts, and classes of estuarine and floodplain habitat available to juvenile salmonids; variability in salinity, temperature, water depth, velocity, dissolved oxygen, and turbidity; habitat-salmon associations; sedimentation rates; salmon and habitat conditions in the transition zone; long-term variability and trends in the size, timing, and abundance of hatchery and wild outmigrants from the Columbia River; and the relative effects of inflow from upriver, changes in bathymetry due to the navigation channel, and changes in habitat due to other forms of development. Under this action item, the Corps and BPA are expected to develop programs to build an understanding of these matters and, in the relatively short term, to develop criteria for estuary habitat restoration on the basis of the best available information.

Action 159: BPA and the Corps, working with LCREP and NMFS, shall develop a plan addressing the habitat needs of salmon and steelhead in the estuary.

BPA and the Corps, working with LCREP and NMFS, will develop specific plans for salmon and steelhead habitat protection and enhancement. These plans should contain clear goals for listed salmon conservation in the estuary, identify habitats with the characteristics and diversity to support salmon productivity, identify potential performance measures, identify flow requirements to support estuarine habitat requirements for salmon, and develop a program of research, monitoring, and evaluation. The plans should be completed by 2003.

Action 160: The Corps and BPA, working with LCREP, shall develop and implement an estuary restoration program with a goal of protecting and enhancing 10,000 acres of tidal wetlands and other key habitats over 10 years, beginning in 2001, to rebuild productivity for listed populations in the lower 46 river miles of the

Columbia River. The Corps shall seek funds for the Federal share of the program, and BPA shall provide funding for the non-Federal share. The Action Agencies shall provide planning and engineering expertise to implement the non-Federal share of on-the-ground habitat improvement efforts identified in LCREP, Action 2.

Much of the complexity of the estuary's historic shallow-water habitat and much of the estuary's saltwater wetlands have been lost due to the effects of local, navigational, and hydropower development. LCREP proposes a 10-year program to protect and enhance high-quality habitat on both sides of the river to support salmon rebuilding. A high priority should be put on tidal wetlands and other key habitats to rebuild productivity in the lower 46 river miles. Federal agencies will provide technical and financial support for this program and for efforts to implement on-the-ground activities identified in planning.

As more information is gained from inventory and analytical work, the 10,000-acre goal may be modified to ensure that habitats that are determined to be important to the survival and recovery of anadromous fish are addressed. Examples of acceptable estuary habitat improvement work include the following:

- Acquiring rights to diked lands
- Breaching levees
- Improving wetlands and aquatic plant communities
- Enhancing moist soil and wooded wetland via better management of river flows
- Reestablishing flow patterns that have been altered by causeways
- Supplementing the nutrient base by importing nutrient-rich sediments and large woody debris into the estuary
- Modifying abundance and distribution of predators by altering their habitat
- Creating wetland habitats in sand flats between the north and south channels
- Creating shallow channels in inter-tidal areas
- Enhancing connections between lakes, sloughs, side channels, and the main channel

The Corps and BPA will put high priority on improving access to and the quality of chum habitat, especially in the Grays River. The work outlined in this action is in addition to any mitigation/restoration work that may be connected to the Corps' channel-deepening project.

Action 161: Between 2001 and 2010, the Corps and BPA shall fund a monitoring and research program acceptable to NMFS and closely coordinated with the LCREP monitoring and research efforts (Management Plan Action 28) to address the estuary objectives of this biological opinion.

Action 162: During 2000, BPA, working with NMFS, shall continue to develop a conceptual model of the relationship between estuarine conditions and salmon population structure and resilience. The model will highlight the relationship among hydropower, water management, estuarine conditions, and fish response. The work will enable the agencies to identify information gaps that have to be addressed to develop recommendations for FCRPS management and operations.

Action 163: The Action Agencies and NMFS, in conjunction with the Habitat Coordination Team, will develop a compliance monitoring program for inclusion in the first 1- and 5-year plans.

Compliance monitoring is necessary to determine how well management actions are implemented. From a regulatory perspective, compliance monitoring is necessary to ensure that agencies and individuals responsible for mitigation or restoration activities complete their responsibilities. From a biological perspective, NMFS must know how well a management action is implemented. If salmon do not respond, NMFS will be able to distinguish between management that did not work and management that was not implemented.

Some compliance monitoring will be conducted during the monitoring and evaluation program outlined in Section 9.6.5. However, not all sites will be checked at the appropriate intervals during this program. Therefore, the agency or party conducting each action will be responsible for keeping a log book of implementation, which is entered monthly into a web-based data archive. NMFS will randomly send out field staff to check on the log books and validate their entries.

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9.6.3 Harvest Measures

9.6.3.1 Overview

Fisheries that affect listed fish originating in the Columbia River basin, whether in the tributaries, the mainstem, or the ocean, have been and continue to be subject to biological opinions addressing harvest. In all cases, fisheries must be operated to avoid jeopardizing listed species. This opinion addresses the operation and management of FCRPS, not harvest. Harvest management is not within the authorities of the Action Agencies; therefore, additional constraints cannot be imposed on fisheries by this biological opinion. Instead, this section outlines harvest measures the Action Agencies can facilitate to meet offsite mitigation goals for hydrosystem impacts and measures that may further reduce the take of listed species. The Action Agencies can contribute to the development and deployment of selective fisheries potentially reducing impacts on listed fish and allowing increases in harvest without raising impacts on listed fish. This section outlines changes in the fishery management system that are critical to the successful deployment of selective fishery measures and harvest reforms that will increase the certainty and efficacy of new and existing harvest management regimes, thereby raising the margin of safety afforded to listed fish.

Fisheries in the Columbia River basin have been significantly reduced in recent years in response to a number of factors that include a general decline in abundance, an increasing scientific and policy awareness of the importance of managing fisheries for natural stocks and stock groups, improved management capabilities, and the requirement to reduce impacts on listed species. Many reviewers of the draft biological opinion correctly pointed out that harvest managers have been implementing harvest reforms for many years. Weak stock management, abundance-based management, harvest rate and escapement goal management, and other kinds of major advancements (i.e., reforms) have been used for some time and continue to evolve and improve. Some reviewers believe that harvest managers have been responding to the declining status of natural fish caused largely by non-fishing factors, at great cost to their fisheries, economies, and cultures. They also point out that further reductions in harvest may benefit some species, such as Snake River fall chinook or Snake River steelhead, but that such additional reductions, even if achieved, will not help recover listed species.

The decline in the status and abundance of natural populations has many causes, including, but not limited to, the development and operation of FCRPS. It will take a long time for recovery efforts to show positive results. Thus, harvest constraints now in place must continue for some time so as not to thwart other recovery efforts. New and/or expanded harvest reforms, such as those that increase the selectivity of fisheries either by avoiding contact with listed fish or by reducing the mortality rate of listed fish released from fisheries, offer the potential to reduce impacts on some listed ESUs. It may be possible to realize this potential without net reductions in harvest and to increase total harvest without increasing impacts on listed ESUs. If successfully implemented, such reforms would provide easily quantified survival benefits for listed fish. The reforms provide potential opportunities for the Action Agencies to meet offsite mitigation goals. To the extent that the reforms are facilitated by the Action Agencies, it should be possible to allocate these benefits.

For most of the listed ESUs, opportunities to improve survival through additional harvest reductions are limited because they are not affected, or are affected only minimally, by today's much-reduced fisheries. Impacts on those ESUs that still are affected by harvest occur in fisheries targeting healthy and abundant stocks, particularly hatchery stocks. Even for the ESUs affected by these incidental harvests, impacts already have been greatly reduced in recent years in response to declining abundance of nonlisted as well as listed species. As a result, even the complete elimination of all remaining fisheries would yield only limited benefits for many of the ESUs.

Some who commented on the draft opinion advocated further reductions in harvest, in some cases its complete elimination. They argued that reducing harvest is more cost-effective than other recovery measures, that it provides more certain benefits to listed fish, and that it more closely matches the intent of ESA because it prohibits the killing of listed species. Others disagreed, pointing out that extreme harvest reductions have already occurred, that the harvest sector has already paid more than its fair share, that additional harvest constraints can do little to change the basic productivity of natural stocks, and that current harvest constraints fail to meet Tribal obligations. NMFS acknowledges the validity in each of these views, but respectfully disagrees that they make a compelling case to implement any of the more extreme alternatives. The solution to the recovery problem cannot be found in the complete elimination of harvest, in sacrificing what little remains of an entire sector, or in further exacerbating an already extreme burden on the Tribes, as a prerequisite to changes in other sectors. Nor can it be found in allowing increases in harvest simply because harvest constraints have been "proven" not to recover listed species, or because reasoned arguments exist as to why the current allocation of the conservation burden is unfair.

NMFS' overall approach to recovery, and the reasoning that supports it, is described in greater detail in the Basinwide Recovery Strategy, which provides the broader context for this biological opinion. For harvest, the approach described in the Basinwide Recovery Strategy is to constrain ocean and inriver harvests at or below recently established rates to allow time for other recovery measures to take effect. As noted above, this opinion cannot mandate and, therefore, does not presume that additional reductions in harvest relative to those described in the Basinwide Recovery Strategy will occur. However, maintaining harvest constraints is critical to the success of recovery efforts. In a few cases, additional harvest reductions would substantially increase the prospects, and may actually be necessary, for recovery. The scientific risk assessments that inform this biological opinion assume that, at the very least, recently established harvest constraints and their associated survival benefits will be maintained. It is, therefore, both reasonable and prudent for the Action Agencies to contribute to measures to ensure that these constraints continue, to increase the certainty and efficacy of harvest management measures and, thereby, the margin of safety afforded listed fish, and to enable additional reductions through improved fishery selectivity. This is particularly true for the immediate future, since harvest measures yield immediate benefits while other measures to increase survival of listed fish require more time to produce benefits.

This RPA does not assume that the Action Agencies will provide all of the funding necessary to implement the harvest actions described here, as some are clearly the responsibility of those with harvest management authority. As stated previously in this biological opinion, where offsite mitigation actions imposed on the Action Agencies by this RPA overlap with the responsibilities of other Federal and non-Federal entities, an appropriate sharing of costs and implementation responsibilities must be worked out.

9.6.3.2 Measures to Reform Harvest

This RPA defines harvest reform broadly; it includes implementing various kinds of harvest management reforms such as selective fishery management strategies (e.g., mark-selective fisheries), developing and applying alternative fishing methods and gear types, and creating or expanding fishing opportunities in areas or at times when listed fish are not present. As noted previously, many harvest reforms have already been implemented by the fishery managers. Realizing the full potential of harvest reforms, however, requires development and implementation of new and more broadly applied selective fishing techniques, as well as augmenting and/or modifying existing programs and tools for managing fisheries, including systems for monitoring and evaluating stock and fishery-specific impacts. Because most or all hatchery fish will have to be marked to improve information on the status of natural populations and/or to enable mark-selective fisheries, existing catch sampling and stock identification programs and methodologies will have to be modified and significantly augmented, both inside and outside of the basin. Existing management and assessment tools, including various models, analytical methods, procedures, and associated databases, will also have to be refined and/or replaced.

The Basinwide Recovery Strategy particularly emphasizes the development, implementation, and expansion of mark-selective fisheries. Mark-selective fisheries are not recovery tools, but rather means to allow fishing to continue. Used primarily in certain recreational fisheries, mark-selective fisheries also may provide significant economic benefits to commercial fisheries that use live-capture selective fishing techniques. Live-caught fish can be delivered to buyers in better condition, potentially enhancing their market value. Thus, mark-selective and other forms of selective fishing may contribute to meeting multiple objectives, including FCRPS mitigation mandates, FCRPS offsite mitigation responsibilities, and Tribal and non-Tribal fishery obligations.

Realizing the full potential of selective fishing depends on a number of elements, both technical and policy-level. Before the strategy would work in Tribal fisheries, social, economic, and cultural impacts would have to be addressed in ways the Tribes support. The fishers must fish in times or places where encounters with listed fish are minimal, or they must use gear and methods that allow fish to be caught alive, so that those needing protection can be released with a minimal amount of handling loss. In selective fisheries based on live-catch strategies, it must be possible and practical for the fishers to visually sort between fish that are harvestable and those that are not. Sorting between different species—sockeye versus chinook, for example—is fairly straightforward and promising for certain fisheries in the Columbia River basin, including some that would sort between healthy natural stocks and listed stocks. However, selectivity directed towards the harvest of hatchery fish in mixed stock fishing areas, including the mainstem, will rely on mass marking of hatchery-produced fish. Fortunately, it is now feasible to mass-mark hatchery fish using new, relatively economical technologies, but those technologies must be widely used to make mark-selective fisheries feasible in mixed stock areas. Sufficiently precise and accurate methods must exist to estimate incidental mortalities on fish that are captured and released. Methods for maintaining critical management systems must be developed and deployed so that managers can maintain and enhance their ability to monitor and evaluate the effects of fisheries and the status of stocks.

Some selective fishing strategies are designed to avoid catching listed species in the first place. These can reduce the catch of listed species in fisheries targeting strong runs. An example of this strategy is the gill net exchange program recently developed by the Action Agencies, Tribes, and Federal agencies. This program, partially implemented in the autumn 2000 mainstem Tribal fishery, should be assessed for economic, legal, and social implications and, if appropriate and agreed to by the Tribes, expanded in the future. Canadian fishers and managers are engaged in an ongoing, multiyear program to develop and assess innovative techniques to minimize the catch of weak natural runs. One such technique involves using “weed lines” on gill nets in the Skeena River to reduce impacts on depressed steelhead runs in the commercial salmon fishery. These and other avoidance techniques should be investigated for application in Columbia River basin fisheries.

9.6.3.2.1 Measures to Develop or Expand Use of Selective Fishing Methods and Gear

Action 164: The Action Agencies shall work with NMFS, USFWS, and Tribal and state fishery management agencies in a multiyear program to develop, test, and deploy selective fishing methods and gear that enable fisheries to target nonlisted fish while holding incidental impacts on listed fish within NMFS-defined limits. The design of this program and initial implementation (i.e., at least the testing of new gear types and methods) shall begin in FY 2001. Studies and/or pilot projects shall be under way and/or methods deployed by the 3-year check-in.

The purpose of this action is to enable the development and deployment of selective fishing gear and methods so some level of fishing can continue even when listed fish are present. Because it will take time to develop, test, refine, and deploy different types of methods and gear in various conditions, this action necessarily will involve a continuing, multiyear program.

The effectiveness of new selective fishing gear and methods depends to a large degree on whether they are accepted by the fishers. The program to develop and test selective fishery options should engage members of the fishing community, drawing on their proven abilities to find innovative and practical solutions to fishing-related problems. Funding should be made available and proposals solicited from agencies, Tribes, industry, and the public to develop and test selective fishing methods and/or gear using carefully designed and monitored applied experiments. Live-capture fishing gear and methods such as traps, seines, tangle nets, and revival tanks should be explored. The program should be implemented as soon as possible, building on the experiences of the Canadians, states, and Tribes. Strategies that work should be deployed as broadly and quickly as possible. The program also should include exploration of methods and strategies to reduce incidental fishing mortalities in fisheries, regardless of whether they use conventional or live-capture gear types.

9.6.3.2.2 Measures to Address Effects of Selective Fishing on Fishery Management Systems (e.g., Fishery Management and Stock Assessment Models)

Action 165: The Action Agencies shall work with NMFS, USFWS, Tribal and state fishery managers, and the relevant Pacific Salmon Commission and Pacific Fishery Management Council (PFMC) technical committees to develop and implement methods and analytical procedures (including revising and/or replacing current fishery management and stock assessment models based on these methods and procedures) to estimate fishery and stock-specific management parameters (e.g., harvest rates). The Action Agencies shall place particular emphasis on current methods and procedures affected by the transition to mass marking of Columbia River basin hatchery produced fish and/or deployment of selective fishery regimes in the Columbia River basin, addressing these concerns within a time frame necessary to make the new selective fishing regimes feasible. Specifically, the Action Agencies shall facilitate the development of models, methods, and analytical procedures by the 3-year check-in.

Current harvest management strategies and stock assessment tools, especially including the models used to implement and monitor them, evolved in the context of non-selective fisheries. These models have long played a crucial role in the management of ocean and freshwater fisheries and in stock assessment programs. Most of them are based on data acquired over the last two decades from the coastwide CWT program. The models include the coastwide chinook model the United States and Canada used to implement and monitor the chinook regime contained in the Pacific Salmon Treaty and similar models developed and used by the PFMC and the *U.S. v. Oregon* Technical Advisory Committee. These modeling tools were not designed to accommodate selective fisheries; they evolved in the context of non-selective fisheries, using the basic assumption that the catch in a fishery represents a random removal of fish from the fishery population. With the advent of mass marking and selective fishing, this key assumption is no longer valid. Because it is more critical than ever to sustain and enhance the stock and fishery-specific information and analyses that these tools provide, the models and associated analytical techniques must be substantially revised or replaced. This will be a significant but necessary undertaking. Besides maintaining and enhancing critical fishery management and stock assessment capabilities, this action will help ensure compliance with the Pacific Salmon Treaty and other agreements.

Fishery management models and related management systems in the various areas and fisheries are interdependent. Changes in ocean fisheries management and strategies affect river fisheries and vice-versa. Clearly, this action item involves matters that overlap with the responsibilities of the fishery managers. As stated previously, an appropriate sharing of costs and implementation responsibilities must be worked out among the relevant parties.

Action 166: The Action Agencies shall work with NMFS, USFWS, the Pacific States Marine Fisheries Commission, and Tribal and state fishery management agencies to implement and/or enable changes in catch sampling programs and data recovery systems, including any required changes in current databases (e.g., reformatting) and associated data retrieval systems, pursuant to the time frame necessary to implement and monitor mass marking programs and/or selective fishery regimes in the Columbia River basin. Specifically, the Action Agencies shall facilitate the revision of programs and systems, as needed, by the 3-year check-in.

Changes in fishery monitoring and data systems will be necessary to provide the degree of resolution required to monitor the status of listed populations while enabling some continued fishing. For years, the adipose fin clip was used solely to identify fish that carry a CWT. Now, fish with an adipose clip may or may not carry a CWT, and a fish that has a CWT may or may not have a fin clip. For this reason, significant changes must be made in sampling and monitoring programs. Most notably, electronic tag detectors will be needed to detect and recover CWTs from a broad range of fisheries, natural spawning areas, and hatchery escapements to maintain critical stock-specific and fishery-specific information provided by the CWT system. Fishery management databases, including the coastwide databases maintained by the Pacific States Marine Fisheries Commission on behalf of the states, Tribes, the United States Federal government, and Canada, will have to be modified and reformatted and new protocols adopted to accommodate changes in data types, collection methods, access methods, and use.

Action 167: The Action Agencies shall work with NMFS, USFWS, and Tribal and state fishery management agencies to develop improved methods for estimating incidental mortalities in fisheries, with particular emphasis on selective fisheries in the Columbia River basin, doing so within the time frame necessary to make new marking and selective fishery regimes feasible. The Action Agencies shall initiate studies and/or develop methods by the 3-year check-in.

Even selective fisheries cause some level of incidental mortality on listed fish; obtaining sufficiently accurate and precise estimates of this mortality will be critical to the successful implementation of many selective fisheries. For years, incidental mortalities have been estimated from very limited data. For example, a single estimate of hook-and-release mortalities formerly was used to cover ocean fisheries coastwide, regardless of species or type of hook and line used.

Estimates have improved significantly in recent years, but could be improved even more. The same may be true for mark-selective recreational steelhead fisheries. The weak link in estimating incidental mortalities lies in estimating the encounter rate; existing methods for estimating fishery-specific rates must be improved. In the context of listed fish, where even low levels of mortality can affect the prospects for survival and recovery, accurate and precise estimates of incidental mortalities will be essential for determining the extent to which selective fisheries can accomplish their intended purposes. Studies must be conducted in specific fisheries to better estimate these mortalities as a function, for example, of the type of gear used, how it is fished (e.g., net gear "soak time"), water temperatures, and other variables. Estimating the effects of multiple captures of listed fish is a particularly difficult, but critical-to-solve, problem. Failure to do so could undermine the viability of selective fisheries strategies for some species and/or fisheries. In addition to improving estimates of immediate mortalities resulting from catch and release fisheries, studies are needed to focus on the effects of these encounters on subsequent reproductive success.

9.6.3.3 Procedures for Crediting Reductions in Impacts on Listed Fish

Action 168: The Action Agencies shall work with NMFS, USFWS, and Tribal and state fishery management agencies to develop methods for crediting harvest reforms, and the survival benefits they produce, toward FCRPS offsite mitigation responsibilities. A crediting approach shall be agreed upon by the 3-year check-in.

The methods should identify, for example, how much reduction in take occurs as a result of the reforms. Consideration should be given to the extent to which FCRPS contributes funding for development and application of reform measures. Methods must be included for monitoring and evaluating estimated survival benefits over time. The methods for crediting specific reform measures likely will vary. Allocation of survival benefits enabled by harvest reforms is also likely to vary with circumstances. For example, the survival benefits derived from achieving greater selectivity in a given fishery can potentially be used for either or both of two objectives: 1) achieving a higher catch of nonlisted abundant stocks while staying within a harvest rate limit on listed fish, or 2) further reducing the rate of incidental harvest impacts on listed fish while maintaining a particular level of total catch. It is not possible to maximize both objectives simultaneously, i.e., to minimize impacts on listed fish at the same time as maximizing the catch of nonlisted fish.

In some cases, depending on the status of the listed fish, all survival benefits flowing from greater harvest selectivity should accrue solely to escapements. In other cases, however, a portion of the benefits of greater selectivity could accrue to the fishery as a higher total catch. The Action Agencies and the harvest managers should develop and agree to formulas that accommodate both objectives—increases in escapement and increases in total catch—thereby better aligning the interests of the FCRPS with those of the harvest sector. For action items other than those involving the development and implementation of selective fishery methods (where it is relatively easy to quantify survival benefits to listed fish), survival credit to the Action Agencies will be more qualitative. An appropriate crediting formula for offsite mitigation for harvest reforms should take into account a number of considerations, including the extent of reductions in take of listed species enabled by the reforms, the reasons the reforms are necessary, the relative responsibilities of the affected parties and actions they have already taken, and the extent to which the Action Agencies contributed to speeding the pace of the reforms, or the margin of safety they provide.

9.6.4 Artificial Propagation Measures

9.6.4.1 Overview

An extensive amount of artificial production of salmon and steelhead occurs in the Columbia River basin today. Many hatchery programs started decades ago specifically to replace natural production lost as a result of the FCRPS and other development, not to protect and rebuild natural populations. The original design and operation of many programs and facilities reflect scientific knowledge and policy decisions of a previous era. Traditionally, the objective of those hatchery programs was to provide harvest opportunities, a mitigation obligation that remains today. Most were never called upon to produce fish that are viable in nature. To a large degree, the programs succeeded in producing harvestable salmon and steelhead to maintain fisheries, even as natural production declined.

In recent years, changing policies reflect the importance of natural populations and the potential negative effects of hatcheries. As many reviewers of the draft opinion noted, numerous artificial production reforms have been implemented. These reforms strive to reduce negative effects of hatchery production on natural populations while retaining its proven production and potential conservation benefits. For example, hatchery programs are in the process of phasing out use of improper brood stocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from, or more compatible with, locally adapted populations. Producing fish that are better suited for survival in the wild is the explicit objective of programs such as the Yakama Nation's Cle Elum hatchery. Many programs incorporate improved production techniques, such as the NATURES rearing program used by the Nez Perce Tribe. The basic thrust of many of these reforms has been to produce fish that pose less risk to natural populations, either by minimizing interactions with natural populations or by making hatchery fish more compatible with them.

Nevertheless, recovery cannot be achieved simply by releasing more hatchery-produced fish in natural production areas, regardless of their ancestry or how they are produced. Hatcheries cannot provide the productive conditions necessary to restore self-sustaining populations in their natural habitats. It is also recognized that some artificial programs and facilities could be further reformed because they still have deleterious effects on natural populations and/or mask their status. The overarching goal of the reforms described here is to reduce or eliminate adverse genetic, ecological, and management effects of artificial production on natural production while retaining and enhancing the potential of hatcheries to contribute to basinwide objectives for conservation and recovery. The goal still includes providing fishery benefits to achieve mitigation mandates, but now must also include an increased emphasis on conservation and recovery, a mission for which many older programs were not designed. Reforms of existing hatchery programs and facilities that began several years ago must be accelerated and broadened to apply a variety of new and improved artificial production techniques that include supplementation, captive brood stock, and other strategies designed to minimize the risk of artificial production and/or maximize its conservation benefits.

These reforms require substantial and costly changes in existing programs and facilities, beginning with a rigorous review of their goals and objectives. An implicit but fundamental premise of the approach described in the Basinwide Recovery Strategy and this biological opinion is that artificial production programs can be operated consistent with, and complementary to the goals of the ESA, while still achieving fishery mitigation objectives. Because there is a range of scientific and policy opinions regarding the purpose and appropriate application of artificial production in specific circumstances, a number of strategies, coupled with an adaptive management approach, are warranted and, with the help of the Action Agencies, are prescribed here.

In applying the ESA to listed species, NMFS focuses on biological requirements. NMFS' understanding of these requirements derives from many sources, including the general conservation literature, specific NMFS studies of salmon, as well as by others, and recommendations of the Tribes, state, and other Federal fish and wildlife agencies and experts. NMFS recently published a compilation of scientific information in "Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units" (McElhany et al. 2000). This document identifies criteria and guidelines relevant to the needs of salmonid populations. Hatchery programs can affect these biological needs. Accordingly, subsequent to the listings, NMFS began to address these programs in biological opinions issued or still in progress under Sections 7 and 10 of the ESA for hatchery programs throughout the Columbia River basin. In those biological opinions, as in this one, NMFS focuses on reducing the deleterious effects of artificial production on listed species. Deleterious effects must be eliminated or reduced enough to avoid jeopardizing listed species and to provide for their survival and recovery. NMFS' biological opinions have led to substantial changes in artificial production programs throughout the region.

In determining the extent of necessary reforms of hatchery programs, and the rate at which they must occur, NMFS considers a number of factors. These include, but are not limited to, the amount of benefit to listed fish accruing from the proposed reform, the extent of improvement already achieved from earlier reforms, the cost of the reforms (both economic and in terms of impacts on other goals and objectives), how quickly they can be implemented, how soon they will produce results, and how well the benefits to the fish can be measured. While all these factors must be considered in hatchery biological opinions, a consistent approach to hatchery reforms should be employed throughout the Columbia River basin, always with the result being a determination that each proposed hatchery program will be operated in a way that does not jeopardize listed fish.

Because the difference between jeopardy and no jeopardy is seldom a bright line, the consultation process also focuses on the margin of safety that artificial production programs should achieve and the pace at which reforms must be implemented. This is an area where the Action Agencies have a substantial opportunity to contribute to the survival of listed species. To the extent that the Action Agencies contribute additional resources (i.e., resources beyond those that they are already obliged to provide to comply with hatchery biological opinions and, thus, continue to meet their mitigation responsibilities), they can satisfy survival goals within the meaning of this biological opinion.

In addition to reforms of current hatchery programs, another opportunity exists for the Action Agencies to contribute to the survival of listed species. Numerous populations in the upper Columbia and upper Snake river basins are in such bad condition that extinction may be imminent in the near term. Actions in the habitat and hydrosystem sectors designed to improve the status of these populations may not occur due to lack of resources, or may not have the intended effect soon enough to avoid extinction. Given the status and trends of these populations, the potential benefits of intervening with artificial production actions, i.e., safety-net programs, may outweigh the risks of such intervention. The Action Agencies can provide resources to implement such strategies where NMFS determines they are appropriate. Credit should accrue to the Action Agencies for artificial production actions undertaken specifically to avoid extinction, as this clearly constitutes a positive contribution to the survival of the listed populations.

Scientific knowledge regarding the benefits and risks of artificial production is incomplete, but improving. Artificial production measures have proven effective in many cases at alleviating near-term extinction risks, yet the potential long-term benefits of artificial production as a recovery tool are unclear. Scientific uncertainty remains about whether and to what extent hatcheries, as they are currently operated, pose a continuing risk to natural populations. The Action Agencies can further achieve the offsite mitigation goals by investing in research, monitoring, and evaluation to address these uncertainties. These investments may eventually manifest themselves in improved survival of listed fish. NMFS will work with the Action Agencies on a method for recognizing the benefit of these efforts.

A number of studies and reviews of artificial production in the Columbia River basin have occurred in recent years; some are described later in this section. Although their scope is different from NMFS' focus under the ESA and in this biological opinion, their findings and recommendations generally are consistent with the measures identified here. In general, the standards and guidelines that emerge from these reviews are aimed at improving the effectiveness of artificial production programs, minimizing deleterious impacts on natural populations, meshing hatchery production and policies with harvest objectives, and increasing accountability and efficiency in hatchery programs. Integrating hatchery and harvest policies is especially important to meeting obligations for Tribal and non-Tribal fisheries.

9.6.4.2 Actions to Reform Existing Hatcheries and Artificial Production Programs

Recent studies recommending hatchery reform include the NWPPC's Artificial Production Review, several scientific reviews such as the NRC's Upstream Report (NRC 1996), the NWPPC's "Return to the River Report" (ISG 1996), and others found in the literature. NMFS also has published several papers relevant to artificial production, including the Interim Policy on Artificial Propagation of Pacific Salmon under the Endangered Species Act (April 5, 1993, 63

FR 17573), and the previously mentioned VSP report. In general, these studies reach similar conclusions about the types of reforms necessary to reduce deleterious effects while still allowing continued use of hatchery production to provide Tribal and non-Tribal harvest opportunities.

The detrimental impacts of artificial production can be categorized into 1) genetic effects resulting from domestication, artificial selection, inbreeding, straying, and stock transfers; 2) ecological interactions such as competition and predation; and 3) management effects, such as occur when fisheries are managed at high rates to take hatchery fish, resulting in excess harvest of natural fish. In addition, there is the masking effect of hatchery fish that confounds NMFS' ability to determine the status of natural populations. While many hatchery reforms have been or are in the process of being implemented, much remains to be done.

From the recent studies, a fairly extensive menu of measures has been identified, and specific actions to implement the measures have emerged. This does not imply that they are all ready to go. In fact, the process of hatchery reform involves a systematic review, program-by-program and hatchery-by-hatchery, to determine on a case-by-case basis which of the measures and actions to apply and when and how they should be implemented. The actual implementation of these measures and actions, whether they involve capital expenditures, operation and maintenance improvements, staffing, and/or other matters constitutes what is meant by artificial production reform throughout this opinion. Efforts to apply these reforms, already underway in many cases, must be expanded and accelerated to programs and facilities throughout the Columbia River basin. Hatchery reform should occur within a broader context of planning in the Columbia River basin designed to clarify goals, objectives, and performance criteria of a basinwide approach for all species to improve accountability and effectiveness. This broader approach includes the development of subbasin plans for management of all species and recovery plans for listed species. They will include, among other things, a better integration of hatcheries and harvest objectives and strategies. The menu of reform measures and actions is represented in the following list:

- Reform measures to clarify the goals, objectives, and performance criteria of hatchery programs to improve accountability and meet subbasin and recovery plan objectives:
    - Develop, clearly articulate, and commit to specific artificial propagation plans.
    - Identify and implement specific monitoring and evaluation protocols at all relevant scales (i.e., varying from basinwide to facility-specific protocols).
    - Apply adaptive management principles by linking future activities to research, monitoring, and evaluation outcomes.

- Reform measures to manage genetic risks to listed species and meet subbasin and recovery plan objectives:
    - Discontinue interbasin transfers of stocks.
    - Phase out inbred, domesticated, and inappropriate composite broodstocks.

  - Produce fish derived from locally adapted stocks to the extent feasible and appropriate.
  - Employ mating protocols designed to avoid genetic divergence from the biologically appropriate population.
  - Manage the number of hatchery-produced fish that escape to spawn naturally, employing limits that will vary depending on the origin of the broodstock, the management objective, and the status of the affected natural populations.
  - Employ hatchery practices that reduce unwanted straying of hatchery fish, for example by acclimating them to desired return areas.

- Reform measures to manage ecological risks to natural populations and meet subbasin and recovery plan objectives:
  - Minimize competition between hatchery and natural fish, for example, by avoiding production that exceeds the carrying capacity of limiting habitats.
  - Minimize predation and other negative interactions between hatchery and natural fish, for example, by producing fish similar in size, behavior, and life history characteristics to the naturally produced fish in the same waters.

- Reform measures to improve hatchery effectiveness and meet subbasin and recovery plan objectives:
  - Design hatchery facilities to mimic natural incubation and rearing conditions.
  - Design facilities for acclimation and release of smolts to improve homing fidelity.

- Reform measures to avoid management risks associated with hatchery production and meet subbasin and recovery plan objectives:
  - Design, implement, monitor, and evaluate the hatchery program consistent with a comprehensive restoration plan.
  - Design and conduct fishery augmentation programs so that fish can be harvested without undue impacts on weaker runs.
  - Mark hatchery-produced fish to distinguish natural from hatchery fish on spawning grounds, in dam counts, and in fisheries.

To facilitate the application of hatchery reforms to specific artificial production programs and projects, NMFS supports what is called a hatchery and genetic management plan (HGMP). NMFS developed the HGMP in collaboration with other Federal agencies, states, and Tribes. It provides a standardized approach and a consistent body of relevant information about artificial production programs. A NMFS-approved HGMP contains a clear statement of the purpose and goals of the program or project and its relationship to harvest and other management goals. It comprehensively addresses facility and operational details relevant to reform measures and action items identified above. It requires that an appropriate monitoring and evaluation plan be developed and implemented for that facility or program. Research critical to the success of the project must also be identified.

NMFS considers an approved HGMP to be a necessary step in assessing artificial propagation programs. It is anticipated that HGMPs will evolve over time into more comprehensive and detailed documents as additional focus and resources are brought to bear on hatchery reform and as new information becomes available.

The development of NMFS-approved HGMPs is a substantial task that must be completed before many actual reforms can be implemented. Additionally, the process of hatchery reform does not end with a completed NMFS-approved HGMP. Rather, hatchery reform will be a continuing process of implementing, monitoring, evaluating, and revising the HGMP plans. Priority should be assigned to circumstances that affect populations in the most critical condition.

There is also an immediate need to enable differentiation between hatchery and naturally produced salmon. As explained in the critical research section, uncertainty about the number of hatchery-origin versus natural-origin fish on the spawning grounds confounds our ability to assess and monitor natural population status and growth rates. This masking problem can be addressed by marking hatchery production, but must also include improved sampling efforts and specific experiments (e.g., radio tagging) to determine relative distribution and timing of hatchery and natural spawners. It is particularly urgent to mark the most at-risk species such as spring chinook and steelhead.

Action 169: The Action Agencies shall fund the development of NMFS-approved HGMPs for implementation, including plans for monitoring and revising them as necessary as new information becomes available. HGMPs have to be completed first for the facilities and programs affecting the most at-risk species (Upper Columbia and Snake River ESUs), followed by those affecting mid-Columbia, and then the Lower Columbia ESUs. HGMPs for all the Columbia basin hatchery programs and facilities should be completed (and approved by NMFS) by the 3-year check-in.

Action 170: Using new authorizations and appropriations and/or BPA funds as necessary and appropriate, the Corps, working with USFWS, shall oversee the design and construction of capital modifications identified as necessary in the HGMP planning process for Lower Snake River Compensation Plan anadromous fish hatchery programs. These improvements shall begin immediately after the relevant HGMPs are completed and approved by NMFS, and shall be completed as expeditiously as is feasible. BPA shall provide for the operations and maintenance costs of these reforms and shall reimburse the Federal Treasury for an appropriate share of the capital costs. The Corps shall have begun to implement reforms for programs affecting the most at-risk species by the 3-year check-in.

Action 171: BOR shall implement the reforms identified in the HGMP planning process for the Grand Coulee mitigation anadromous fish hatchery programs, beginning immediately following completion of the relevant (NMFS approved) HGMPs and completing the work as expeditiously as feasible. BPA shall fund the operations and maintenance costs of the reforms and shall reimburse the Federal Treasury for an appropriate share of the capital costs. BOR shall have begun to implement reforms for programs affecting the most at-risk species by the 3-year check-in.

Action 172: The Corps shall implement the reforms identified in the HGMP planning process for the Corp's Columbia River basin mitigation anadromous fish hatchery programs, beginning immediately after the relevant HGMPs are completed and are approved by NMFS. The work shall be completed as expeditiously as feasible. BPA shall fund the operations and maintenance costs of the reforms and shall reimburse the Federal Treasury for an appropriate share of the capital costs. The Corps shall have begun to implement reforms for the programs affecting the most at-risk species by the 3-year check-in.

Action 173: BPA shall implement the reforms identified in the HGMP planning process for Federal and Federally funded hatcheries, beginning immediately after the relevant HGMPs are completed and approved by NMFS. The work shall be completed as expeditiously as possible. BPA shall have begun to implement reforms for the programs affecting the most at-risk species by the 3-year check-in.

BPA is currently responsible for the power-allocated share of O&M and capital costs associated with reforms that will be required under hatchery biological opinions. To the extent that the Action Agencies seek credit for reforms above and beyond this level, appropriate cost-sharing arrangements will have to be worked out between them and other entities involved in funding the particular hatchery program.

Funding for necessary reforms at Mitchell Act facilities will be sought through congressional appropriations. To the extent that such additional appropriations are not forthcoming, or are insufficient to accomplish all needed reforms as rapidly as possible, however, offsite mitigation crediting could occur at any artificial production facility if the Action Agencies make funds available for that purpose.

Action 174: Working through regional prioritization processes to the extent feasible and in coordination with NMFS, BPA shall collaborate with the regional, state, Tribal, and Federal fish managers and the Pacific States Marine Fisheries Commission to enable the development and implementation of a comprehensive marking plan. Included in this action are the following four steps:

1. Develop a comprehensive marking strategy for all salmon and steelhead artificial production programs in the Columbia River basin by the end of 2001.

2. Provide funding by March 1, 2001, to begin marking all spring chinook salmon that are currently released unmarked from Federal or Federally funded hatcheries.

3. Provide funding, beginning in FY 2002, to implement the Action Agencies' share of the comprehensive marking plan for production not addressed in (2) above.

4. Obtain funding contributions as appropriate for additional sampling efforts and specific experiments to determine relative distribution and timing of hatchery and natural spawners.

9.6.4.3 Actions to Create an Artificial Propagation Safety-net Program

As noted previously, a number of salmon and steelhead populations in the upper Columbia and Snake river basins are at particularly depressed levels, with many facing a high risk of extinction in the near term. For many of these, new safety-net projects designed to intervene with artificial production techniques may be appropriate to prevent extinction. Designed only to prevent extinction, these are not intended to be permanent projects, and they do not serve as substitutes for addressing the factors of decline.

A four-step process will generally be applied to an individual population being considered for a safety-net project, starting with an extinction risk analysis to identify populations that are candidates for intervention. Second, intervention options will be developed, and a proposed strategy will be outlined. Third, a benefit-risk analysis for the proposed strategy will be conducted to determine whether intervention is warranted. Fourth, an HGMP will be developed to guide implementation of the safety-net project. Planning for a safety-net program must be conducted on an accelerated basis so that, if warranted, the project can be implemented expeditiously. The planning process will necessarily rely on available information that will vary significantly between populations and species. The purpose of the safety-net program will not be achieved, and additional populations may go extinct, if the process suffers from excessive delay, or awaits additional information that may not exist or be available for some time.

A factor that clearly will affect the scope of the safety-net program over time is future environmental conditions, especially ocean conditions. If environmental conditions improve significantly, the number of populations needing safety-net interventions will decrease. Alternatively, if environmental conditions remain poor or worsen, then more populations will require intervention to arrest further decline in abundance. Given the high costs involved, and the uncertainty over future environmental conditions, and the considerable uncertainty of the benefits and risks of intervention, the safety-net approach necessarily and appropriately will involve a mix of strategies. Some projects should begin as soon as possible, while others will not occur unless populations continue to decline. Safety-net projects may be as intensely intrusive as the Stanley Basin sockeye recovery program, which anticipated taking the entire population into a captive broodstock program for several years. Others may involve short-term interventions for one or two generations, using more conventional artificial propagation methods such as supplementation using appropriate broodstocks. Preferably, intervention will occur before a population declines to the point that highly intrusive techniques are necessary.

Additional work is needed to identify candidates for the safety-net program, but the individual populations identified below are currently thought to warrant intervention. All are located in the Snake River basin, and some intervention may already have begun. Although some of the most at-risk populations are in the upper Columbia River, the immediate safety-net needs in that area are being addressed pursuant to existing and planned processes tied to non-FCRPS mitigation programs, including commitments from the mid-Columbia PUDs. The need for additional safety-net actions in any part of the Columbia and Snake river basins, and the FCRPS' responsibility to support those actions, depend on future assessments of population status.

Action 175: BPA shall, in coordination with NMFS, USFWS, and the relevant state and Tribal comanagers, fund the four-step planning process described above as quickly as possible and, if so determined by that process, implement safety-net projects as quickly as possible at least for the following salmon and steelhead populations: 1) A-run steelhead populations in the Lemhi River, main Salmon River tributaries, East Fork Salmon River, and Lower Salmon River; 2) B-run steelhead populations in the Upper Lochsa River and South Fork Salmon River; and 3) spring/summer chinook populations in the Lemhi, East Fork, and Yankee Fork Salmon rivers, and Valley Creek.

This action item should be included in a package of early implementation projects. The required planning process should be completed by the end of 2001 so implementation of high-priority, safety-net actions can begin with brood year 2002. [Note: the populations identified in this action item are consistent with those identified by the Tribes on the "A" list of projects.]

Action 176: BPA shall, in coordination with NMFS, USFWS, and the relevant state and Tribal comanagers, fund the development of HGMPs for the Grande Ronde and Tucannon spring/summer chinook safety-net programs.

Based on previous risk assessments, conservation hatchery programs consistent with the safety-net concept already have begun for three populations of spring/summer chinook on the Grande Ronde River and for the single Tucannon River population. Portions of these programs have been accommodated temporarily, but unsatisfactorily, by crowding into existing facilities, with resultant compromises with other ongoing programs. Each conservation hatchery program would benefit from development of an HGMP that identifies the capital and operational needs for these programs and implementation of the HGMP's findings. The Nez Perce Tribe and Confederated Tribes of the Umatilla Indian Reservation are well along in planning for the North East Oregon Hatchery. Coordination between the existing LSRCP safety-net program and North East Oregon Hatchery planning processes is already occurring to a large degree and should continue among USFWS, NMFS, the states of Oregon and Washington, and the Tribes to provide the best, most efficient and expedient, integration of hatchery programs to meet the resource needs of this region. This safety-net action item should be completed by the end of 2001 to accommodate facility development beginning in 2002.

Action 177: In 2002, BPA shall begin to implement and sustain NMFS-approved, safety-net projects.

This action funds the actual implementation and operation of safety-net projects. Depending on the planning results, specific measures may include funding modifications to existing facilities, or construction and operation of new facilities. The obligation to fund the safety-net program, including O&M, monitoring, and evaluation, will continue indefinitely, as circumstances warrant.

Action 178: BPA shall commit to a process whereby funds can be made quickly available for funding the planning and implementation of additional safety-net projects for high-risk salmon and steelhead populations NMFS identified during the term of this biological opinion.

Additional safety-net interventions to prevent extinction of listed populations may be required in the future. The annual offsite mitigation planning process discussed in Section 9.4 (development and implementation of 1- and 5-year plans) may be the appropriate mechanism for providing urgent and quickly needed resources for these interventions. NMFS and USFWS will work with BPA to begin the four-step planning process described above for populations that may require intervention, but that were not addressed in the initial round of projects. Depending on the outcome of the additional assessments and future environmental conditions, resources may be urgently needed for additional populations.

In rare cases, there may be emergency actions that need immediate response, such as unforeseen catastrophic events. In these cases, it may not be possible to wait to complete the HGMP planning process, but will require funding for immediate intervention. In anticipation of these situations, NMFS will work with BPA and the fishery comanagers to devise an appropriate strategy.

9.6.5 Research, Monitoring, and Evaluation Plan

The research, monitoring, and evaluation program that is part of this biological opinion must encompass both the entire salmonid life cycle and the different management areas through which fish pass. This RPA calls for actions affecting fish survival in the hydropower corridor, in tributary habitat, and in the estuary and nearshore ocean environment. In addition, actions in one management arena (other life stages and Hs) may affect the outcomes of FCRPS actions in the hydrosystem corridor (and vice versa). Due to the variety of actions and potential interactions between them, determining the effectiveness of the suite of actions in this RPA will require that a comprehensive (Basinwide Recovery Strategy) monitoring and evaluation program be developed (see action below). Equally important, the performance measures and standards to which actions are being held cannot be determined or judged appropriately in the absence of such a program. Therefore, in the context of this biological opinion, research, monitoring, and evaluation must address five areas:

Population status monitoring. This consists of determining what areas are occupied by juvenile salmonids and spawning adults, assessing the status of the population (i.e., abundance, trend, distribution, and variation), and reviewing status changes through time. Population status monitoring will also provide a baseline against which management actions can be assessed.

Environmental status monitoring. This consists of assessing environmental influences, including non-native species, potentially affecting salmonid populations, and determining whether they change through time, if associations occur between environmental attributes and salmonid population status, and whether these associations suggest that particular management actions should be studied further. Environmental status monitoring will also provide baseline information against which the effectiveness of management actions can be assessed.

Effectiveness monitoring. This consists of assessing whether management actions have the intended effects on the aquatic system and the response of salmonid populations to those effects.

Quality of regional databases. This consists of assessing the accuracy and comprehensiveness of currently available databases that represent habitat quality throughout the basin. This will play an important role in prioritizing what habitat actions should be implemented in which locations.

Compliance monitoring. This consists of assessing whether management actions have been properly implemented and maintained (see also Section 9.6.2).

Overall survival through the life cycle (annual population growth rate) will be a critical measure assessed in the research, monitoring, and evaluation program. Annual population growth rate is a fundamentally important measure of population health. Its use is advisable for the following reasons:

- Use of a population growth rate allows a more biologically meaningful assessment of the effectiveness of an action (or actions) than population size.

- The collective effect of all management actions that serve to improve population health, even if indirectly, can be assessed via growth rate.

- Given that trends or growth rates will be included in recovery goals, it is simple to determine the change in population growth trajectory needed to meet the target and the probability of detecting the effect of actions in a set time frame.

Due to the normal salmonid return times and naturally high variability in salmonid populations, however, it will be difficult to detect population responses using life-cycle response alone. In addition to current juvenile survival monitoring, therefore, the following must have high priority for monitoring and evaluation:

- Developing short-term measures of stock performance that can serve as proxies for standard metrics such as recruits per spawner

- Developing short-term measures of stock performance that focus on the life history stages identified as critically important to population growth in the cumulative risk initiative analysis, i.e., egg-to-smolt, estuarine, and early ocean growth, as well as survival

These short-term measures will determine salmon population growth and, as such, will provide explicit links between population processes and the condition of salmonid habitat. They will also contribute to the performance standards necessary to continually reassess the assumptions inherent in the opinion about the potential gains through offsite mitigation.

Discrete hypothesis testing and resolution of critical uncertainties are very important in the near term to assess the status of the ESUs. They should be central elements of research in the annual plan and will enable determining the measures needed to enhance species survival and recovery in the ESUs. For example, understanding the extent and reproductive success of natural spawning of hatchery fish and the delayed mortality of fish passing dams, either by transportation or inriver, are critical needs. Such information is needed to form meaningful conclusions in the other categories of monitoring and evaluation described above. Progress on resolving these uncertainties is a primary consideration in the biological opinion, for annual and 5-year planning, and for the 5- and 8-year check-ins.

The following sections describe elements of a research, monitoring, and evaluation program that the Action Agencies will implement under this RPA. First, a framework for population identification and establishing recovery goals is provided (Section 9.6.5.1). Second, general principles and guidelines for assessing population and environmental status are described (Section 9.6.5.2). This section includes a discussion of specific site sampling in two levels of detail, or tiers. Section 9.6.5.3 describes a general scheme for effectiveness monitoring and lists, in detail, a number of studies essential for resolving critical uncertainties in the areas of population status, tributary habitat, hatchery management, the hydrosystem corridor, and the estuary/nearshore life-history stages. FCRPS activities and offsite mitigation affect all these areas. Compliance monitoring is addressed both in this section and in Section 9.6.2.

The research, monitoring, and evaluation actions specified in this section are intended to address the need to evaluate the species' status, environmental status, and response to management actions. Such a complete monitoring program is also necessary to establish performance standards and appropriately allocate changes in population status to management actions or environmental conditions. The FCRPS agencies and other Federal and non-Federal entities are expected to contribute to this comprehensive monitoring. The FCRPS agencies are responsible for monitoring and evaluating their actions under the RPA in this biological opinion, as amended by annual and 5-year plans, as well as providing for baseline monitoring necessary to detect changes in population or habitat trends. NMFS anticipates that the cost and implementation of the research, monitoring, and evaluation will be shared among these entities, commensurate with their responsibilities, and will be coordinated through applicable regional processes.

The Action Agencies shall continue or start work on the actions in this RPA concurrent with developing the research, monitoring, and evaluation plan. Actions are not limited to those outlined below if agreement is reached that other actions address critical uncertainties and should begin before the research, monitoring, and evaluation plan is completed. NMFS anticipates that the plan outlined below, and in Appendix G, will be followed, but that it may be modified by identification of other priority actions agreed to by the Action Agencies. The plan may also be modified through the development of the 1- and 5-year implementation plans.

9.6.5.1 Population Identification and Establishment of Recovery Goals

Action 179: The Action Agencies and NMFS shall work with affected parties to establish regional priorities within the congressional appropriations processes to set and provide the appropriate level of FCRPS funding to develop recovery goals for listed salmon ESUs in the Columbia River basin. Tasks shall include defining populations based on biological criteria and evaluating population viability in accordance with NMFS' viable salmonid population approach. These tasks shall be completed by 2003.

Biologically based populations must be defined to establish recovery goals for listed ESUs. Assessing population status (or viability) will be important to gauge needed changes and progress toward those goals. This effort will include assessing genetic differentiation (allele frequencies), environmental and habitat characteristics, life history and morphological traits, demographic information, estimates of straying or migration, and geographic distribution. The Action Agencies will obtain these data for all jeopardized ESUs in the Columbia River basin.

The technical recovery teams will be responsible for developing specific recovery goals by assessing the data compiled through the research, monitoring, and evaluation efforts described above. The Interior Columbia Basin Technical Recovery Team will be convened by late spring 2001 to address recovery planning for all listed ESUs in the interior Columbia River basin. It will probably include separate subgroups to focus on the Snake, Upper Columbia, and Middle Columbia rivers. A separate Willamette and Lower Columbia River Technical Recovery Team has already been formed. Once technical recovery teams convene, tasks should be completed within 18 months. The specific timeline for the relevant tasks is shown in Table 9.6-4. Data collection during ongoing subbasin assessment processes will facilitate this action.

Ultimately, NMFS will describe recovery goals in its recovery plans. As this portion of the plans becomes final, NMFS will use the goals in its analysis of agency actions, and the Action Agencies will take the recovery goals into account in their annual plans for the FCRPS. If the goals entail major changes in analyses or actions, the Action Agencies may have to reinitiate consultation.

Table 9.6-4. Timeline of tasks for establishment of recovery goals.

Task	Product(s)	Completion Date
1. Identify populations.	Population list	Months 3-4
2. Characterize populations (historical and current) based on the following:	Population list with characteristics (a-d).	
a. Abundance/productivity		Months 4-6
b. Diversity		Months 4-6
c. Spatial structure		Months 4-6
d. Habitat capacity		Months 9-10
3. Estimate viability of populations.	Population list with viability status (a-c) and criteria for achieving (if not presently viable)	
a. Abundance/productivity		Months 11-12
b. Diversity		Months 11-12
c. Spatial structure		Months 11-12
4. Provide scenarios that achieve ESU-level viability.	Description of each population's characteristics (a-c above) necessary for ESU viability (multiple scenarios)	Months 12-18
5. Identify factors for decline.	Critical life-stage list	Months 14-15
	Potential factors affecting mortality at different stages	Months 15-18

9.6.5.2 Population Status and Environmental Status Monitoring—Tiers 1 and 2

Action 180: The Action Agencies and NMFS shall work within regional prioritization and congressional appropriation processes to establish and provide the level of FCRPS funding to develop and implement a basinwide hierarchical monitoring program. This program shall be developed collaboratively with appropriate regional agencies and shall determine population and environmental status (including assessment of performance measures and standards) and allow ground-truthing of regional databases. A draft program including protocols for specific data to be collected, frequency of samples, and sampling sites shall be developed by September 2001. Implementation should begin no later than the spring of 2002 and will be fully implemented no later than 2003.

The region will deploy a hierarchical monitoring program in both freshwater and estuarine systems. Appendix G outlines this program, and Table 9.6-5 summarizes the entire monitoring scheme. The monitoring program, including sampling protocols, will be developed by a collaborative effort of the Northwest Forest Science Lab and other regional agencies with monitoring expertise. The participants should have experience implementing comprehensive monitoring and evaluation programs and should include the EPA, the Oregon Coastal Salmon Restoration Initiative, and the Abernathy Fish Technology Center. Technical Recovery Team participation in this process will also be vital, since these data will provide the basis for implementing and confirming specific recovery plan actions. NMFS anticipates that state, Tribal, and local agencies, with Action Agency funding, will have primary responsibility for data collection in this program. The portion of this program implemented in the estuary and nearshore ocean environments must also be coordinated with the Conservation Reserve Enhancement Program, the Columbia River Estuary Study Task Force, and the Corps' analysis of the feasibility of altering flood control rule curves and operations to address mainstem flow objectives.

At a minimum, monitoring developed and conducted under this action will include the two levels of detail, or tiers, outlined below (and in Appendix G) in both freshwater and estuarine/nearshore ocean environments. Performance standards will be defined in terms of measures at both these tiers, enabling future assessment of recovery progress. Data collected at these tiers will also contribute to the Technical Recovery Team process. Specific details of the scheme, such as the distribution of sampling sites, protocols, or procedures to adapt monitoring programs, will be developed during the monitoring and evaluation program development process.

<u>Tier 1.</u> Tier 1 site sampling is the broadest of the sampling levels, comprising the greatest number of sites, sampled at the lowest frequency. It is designed to give the broadest picture of salmonid population status and the condition of the habitats in which they are found. Tier 1 data will contribute to population and environmental status monitoring, database quality, and compliance monitoring. It can contribute to effectiveness monitoring when the expected population response is range expansion. Specific goals associated with this tier are as follows:

Table 9.6-5. Outline of proposed monitoring and evaluation sampling design.

	Tier 1	Tier 2	Tier 3	Landscape imagery	Compliance logbook
Sampling frequency	Once every 3-4 years	Annually	Frequency dependent upon study; minimum annually	Once every 3 years	Once every 6 months (action agency); arbitrarily to monthly (regulatory agency)
Relevant to monitoring types*	1,2,3,4,5	1,2,3,4,5	3,5	2	5
Goals#	A, B	B, C	C, D	B	
Number of sites	To cover all potentially used areas in a population	To be determined by power analyses	Minimum three per ESU; minimum two for each major management action	Entire Columbia Basin	All management actions
Data type -- salmonid population	Presence/ absence	Counts of juveniles and spawners	Dependent on management action; Hatchery spawner reproductive success	None	None
Data type -- habitat	General, qualitative	Qualitative and quantitative	Quantitative, dependent on management action	Landscape-level attributes	None

*Relevant to monitoring types: 1 = population status monitoring, 2 = environmental status monitoring, 3 = effectiveness monitoring, 4 = quality of regional databases, 5 = compliance (implementation) monitoring
Goals: a = establish fish habitat use or range; b = establish associations between environmental characteristics and population status; c = estimate population growth rates or stage-specific survival rates; d = establish mechanistic links between management actions and salmon population response.

- Define areas currently used by adults and juveniles.
- Detect altered status of populations due to range expansion or shrinkage.
- Identify associations between salmon presence and habitat attributes.
- Ground-truth regional habitat quality databases (used in prioritizing management actions and areas for those actions).

Tier 1 sites will be sampled on a 3- to 4-year rotation, with each site being sampled once in that time period. Sites will be distributed to sample the full range of habitats in the area potentially occupied by the population of interest. Distribution should be stratified by channel type, but other stratification may be necessary. A seasonal component will be important, particularly for juvenile surveys, to determine habitat use and availability at different times of the year.

In the estuary, Tier 1 sites will contribute to NMFS' understanding of juvenile salmonid usage of the lower river mainstem, side channel, and estuarine habitats. Of special importance is the extent to which restoring shallow-water estuary habitat might mitigate the additional flood risk resulting from altered rule curves. In addition, this sampling will contribute to developing appropriate indicators of physical and biological change that connect FCRPS flow management operations to the estuarine conditions of salinity, temperature, and suspended particulate matter.

Tier 2.

Tier 2 site monitoring will give a more detailed picture of population status and will allow researchers to assess relationships between environmental characteristics and that status. Tier 2 data will form the backbone of population and environmental status monitoring. It may also contribute to effectiveness and compliance monitoring. Tier 2 data can also be used to compare the status of different populations. Data collected will also function as performance measures (see Appendix G).

For freshwater systems, specific tier 2 goals are defining population growth rates, detecting changes in those growth rates or in relative abundance in a reasonable time, estimating juvenile freshwater abundance and survival rates, and identifying associations between population status or stage-specific survival and environmental attributes (particularly with changes in those attributes over time).

Specific goals associated with tier 2 sampling in the estuary are estimating relative smolt abundance in estuarine/nearshore ocean environments and survival rates during the estuarine phase, detecting changes in relative abundance and survival rates between years, identifying associations between changes in rates of smolt abundance (or survival) and environmental attributes, and identifying associations between history (dam passage route) or parentage (wild versus hatchery) and smolt abundance or survival rates.

Tier 2 sites will be sampled annually. The number of sites to be sampled in each life stage or habitat will be determined by a power analysis. ESUs made up of populations that fluctuate widely will require more tier 2 sites than ESUs with less variable spawner counts. Sites will be distributed probabilistically within a population, ensuring that both good and bad sites are appropriately represented. Some stratification may have to be included (i.e., channel type) in site distribution to obtain the best data.

Juvenile and spawner or redd counts will ultimately provide a measure of egg-to-smolt survival. This will improve estimates of population growth rate and can serve as a baseline for other monitoring efforts (see tier 3).

Action 181: The Action Agencies and NMFS shall work within regional prioritization and congressional appropriations processes to establish and provide the appropriate level of FCRPS funding for a program to acquire and digitize aerial or satellite imagery of the entire Columbia River basin once every 3 to 5 years.

Watershed or sub-watershed level data are critical to prioritize areas for management actions. In addition, these types of data can provide a baseline against which to measure management actions. Finally, large-scale data can contribute to analyses of associations between potentially important watershed-level characteristics and salmon population status. However, much of the relevant large-scale data is not appropriately collected on the ground. This landscape-level data collection will allow a more detailed assessment of land use and land cover variables than is currently available for the region. In addition, the repeated assessment of the variables through time will allow changes in environmental characteristics to be associated with changes in salmonid population status. These data will have value for resource and wildlife management well beyond listed salmon species.

9.6.5.3 Detailed Studies and Effectiveness Monitoring—Tier 3

Several more specific studies, in addition to those outlined in Section 9.6.5.2, will be needed to assess the impact of the management actions undertaken in this RPA and compliance with performance standards. In particular, effectiveness monitoring for hydropower corridor actions, effects of hydropower actions outside the corridor, and effects of offsite mitigation will be critical for determining performance standards. In addition, reducing the uncertainty around the reproductive success of naturally spawning hatchery fish (and, therefore, the current status of wild populations) will require more detailed study.

NMFS anticipates that the Technical Recovery Teams, while coordinating efforts with monitoring and evaluation program development, will prioritize actions and populations for effectiveness monitoring or other detailed study. Below, general guidance for third tier (more detailed) monitoring is outlined. Following that, specific studies that are in progress, that address established critical uncertainties, or that are important to initiate immediately are described in more detail. They fall in the areas of population status, habitat, hatcheries, and hydropower effects on migration, the estuary, and nearshore ocean. The studies described below are those that are not directly associated with a single action (a specific passage improvement, for example), but that are associated with indirect or multiple effects, or more general actions. Monitoring associated with a particular action is described with that action.

9.6.5.3.1 Detailed Studies—General Considerations

Effectiveness monitoring and other more detailed studies can be considered a third tier of a comprehensive monitoring program. To be most effective, these studies must be conducted within an explicit experimental (hypothesis-testing) framework, including both treatment and control sites.

The experimental design of each study will be determined by a variety of factors. When possible, however, these studies should be conducted in the context of a before-and-after control impact (BACI) design, which incorporates temporal and spatial controls, allowing environmental impacts such as ocean cycles to be filtered out. Studies conducted under tier 1 and tier 2 monitoring programs will aid in identifying the important variables by which control and treatment sites should be paired or stratified. Information from other monitoring tiers (especially tier 2) will also provide important controls against which changes in tier 3 studies can be assessed.

Specific sites for these actions (and for controls for those actions) should be identified by considering important environmental factors (or strata), but pragmatic concerns may play a role in choosing some sites. For instance, historically sampled index stocks will be especially valuable contributors to the tier 3 network because their historical time-series offers special opportunities for distinguishing responses to management from chance fluctuations. Local groups may also plan and fund management activities that provide opportunities for detailed effectiveness monitoring.

While the specific data to be collected at this third tier will be tailored to the management action being studied, some general guidelines should be followed. For instance, each study must assess appropriate age-specific survival. In many cases, this may involve several life stages. Sediment reduction, for example, may affect both egg-to-fry and fry-to-smolt survival rates. Whenever possible, PIT tags or other individual marking techniques should be used to follow the fates of individual fish as a function of their history. Such individual studies are important for identifying the effects of environmental conditions that are realized at later life stages. Similarly, size or growth rates, as well as demographic rates, may be important parameters in these studies. In addition, both habitat and population response to the management action should be assessed to identify the factors causing any fish population responses. Finally, as above, appropriate control sites must be paired with the treatment sites to establish unambiguous causal links between actions and environmental or salmon population responses.

9.6.5.3.2 Population Status, Tier 3—Reproductive Success of Naturally Spawning Hatchery Fish is a Critical Uncertainty

Action 182: The Action Agencies and NMFS shall work within regional priorities and congressional appropriations processes to establish and provide the appropriate level of FCRPS funding for studies to determine the reproductive success of hatchery fish relative to wild fish. At a minimum, two to four studies shall be conducted in each ESU. The Action Agencies shall work with the Technical Recovery Teams to identify the most appropriate populations or stocks for these studies no later than 2002. Studies will begin no later than 2003.

Naturally spawning hatchery fish mask the population trajectory of wild populations. This masking not only obscures population status, but also makes it difficult to determine population goals and performance standards with certainty. These studies should identify both the genetic contribution of hatchery-origin spawners to subsequent generations and the temporal and spatial distribution of those spawners.

9.6.5.3.3 Habitat, Tier 3—Effectiveness Monitoring

Because offsite mitigation is required as part of this RPA, and habitat performance measures will be assessed, habitat effectiveness monitoring is necessary. Objectives for this monitoring should be set at a subbasin or smaller scale. Habitat research areas should be identified by assessments and should include management or project actions of greatest potential significance to salmonid productivity in that region. The subbasin assessment template should provide the background context to identify specific monitoring objectives for each region.

In addition, critical information can be gained by initiating experimental studies on readily identifiable general classes of habitat improvement actions. Monitoring and evaluation studies should be initiated in the first 2 years to take advantage of selected opportunities to gain information on the effectiveness of these types of actions in terms of physical standards and juvenile survival criteria or standards (e.g., egg-to-parr survival, egg-to-smolt survival). Study design and selection should take into account the relative change in survival expected in a particular setting, the existence of baseline information, and the ability to detect improvements over the range of life history patterns (e.g., upstream and downstream rearing areas).

Action 183: Initiate at least three tier 3 studies (each necessarily comprising several sites) within each ESU (a single action may affect more than one ESU). In addition, at least two studies focusing on each major management action must take place within the Columbia River basin. The Action Agencies shall work with NMFS and the Technical Recovery Teams to identify key studies in the 1-year plan. Those studies will be implemented no later than 2003.

Each major habitat or hatchery management action should be assessed immediately to obtain enough information for a complete evaluation at the 5- and 8-year check-in points. Management actions falling in this category include the following:

- Attainment of minimum instream flows
- Compliance with water quality standards
  - Alteration of grazing practices
  - Reduction of sediment through road closures
- Enhanced levels of marine-derived nutrients
- Improved riparian conditions
  - Alteration of grazing practices
  - Active stream restoration

9.6.5.3.4 Hatchery, Tier 3—Effectiveness Monitoring

Action 184: The Action Agencies and NMFS shall work within regional prioritization and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for a hatchery research, monitoring, and evaluation program consisting of studies to determine whether hatchery reforms reduce the risk of extinction for Columbia River basin salmonids and whether conservation hatcheries contribute to recovery.

This action item is intended to address the overall research, monitoring, and evaluation needs for artificial propagation in the basin. It exceeds research, monitoring, and evaluation needs associated with specific hatchery programs, projects, or facilities that derive from HGMPs. Reform measures and associated actions are described in Section 9.6.4.2. A conceptual framework for conservation hatcheries is also described by Flagg and Nash (1999).

Initially, the objectives for hatchery research, monitoring, and evaluation will include identifying and evaluating current hatchery production goals and level of effort and ensuring that the goals and level of effort are appropriate to the ecological and genetic effects of hatchery production in the local system. This assessment has several components, including the following actions:

- Estimate (if possible) the carrying capacities of rearing habitat and the migration corridor.
- Determine numbers of naturally spawning first-generation hatchery fish (i.e., hatchery escapement).
- Determine the relative reproductive success of naturally spawning hatchery fish compared to those of wild origin.
- Monitor the size, age, health, and smolt quality (growth), as well as release locations, timing, and life stages of hatchery fish.
- Assess (if possible) the frequency and magnitude of ecological interactions between hatchery and wild fish.
- Assess the genetic variability of populations and metapopulations.

Given these elements of the biological context in which each hatchery program exists, it will be possible to design and/or improve upon hatchery protocols. The goal of hatchery reforms is to reduce or eliminate adverse genetic, ecological, and management effects of hatchery production on natural populations to meet basinwide objectives for conservation and recovery. Thus, the concomitant research, monitoring, and evaluation program would assess the following aspects of natural populations:

- Reduced genetic variation
- Potential transfer of genetic traits from hatchery to wild stock
- Reduced genetic population structure
- Increased ecological interaction with hatchery fish (competition, predation, and disease)
- Masking of natural population status by the presence of naturally spawning hatchery fish

Ultimately, the monitoring and evaluation program must identify hatchery and natural population interactions and isolate their effects on the growth rate of natural populations. To do so, the evaluation program must consider the cumulative effects of hatchery production across the appropriate subbasin, as well as throughout the entire life cycle of the fish. This will require that a relationship be developed between the productivity of the natural populations (as represented, for example, by lambda) and the total production of hatchery fish, which will depend on such factors as survival and productivity during freshwater rearing and seaward migration, ocean residence, and return. Such assessment will provide the statistical power to detect incremental risk of extinction or rates of recovery.

Therefore, for hatchery operation, performance standards must address genetic integrity, abundance, and productivity (recruits per spawner) of both hatchery and wild fish. The information provided by these metrics defines the standards to minimize genetic and ecological risks to listed fish. Flagg and Nash (1999) identify strategies for minimizing genetic and ecological risks. Many of these postulated reforms will require applied research and field testing. Hatchery monitoring and evaluation objectives will operate primarily on a subbasin or smaller scale. The monitoring and evaluation must be tailored to each species produced and address practices that impact the scale of effects (i.e., release practices, logistics of broodstock recovery, and straying of hatchery fish).

9.6.5.3.5 Hydropower, Tier 3—Hydroelectric Project and Reservoir Passage Monitoring and Critical Uncertainties

Research, monitoring, and evaluation programs designed to detect the indirect and direct effects of the hydrosystem are fundamentally different than those associated with hatchery and habitat actions. Rather than recovery-goal-directed actions, operation of the FCRPS is ongoing. Whereas it is important to develop and implement experimental operational or system configuration actions within the FCRPS, long-term monitoring and evaluation of background conditions are also essential in light of the demonstrated and hypothesized effects on salmonids. Therefore, the primary goal of the hydrosystem monitoring and evaluation program is to determine survival rates of migrating juvenile and adult salmonids and to identify factors that contribute to mortality, both direct and indirect. These measures will form the basis for evaluating progress toward attainment of the performance standards for hydro survival.

9.6.5.3.5.1 Juvenile Monitoring and Evaluation

Action 185: The Action Agencies shall continue to fund and expand, as appropriate, fish marking and recapturing programs aimed at defining juvenile migrant survival for both transported and nontransported migrants and adult returns for both groups. These studies shall also compare the SARs of transported and nontransported fish to calculate the differential delayed mortality (D), if any, of transported fish.

Documenting juvenile migrant survival is an important measure of performance objective attainment. Current estimates of D have wide confidence intervals, and D values are one of the critical uncertainties that have to be resolved. This action provides the mechanism for implementing Action 47 (Section 9.6.l.3.3), which requires the Action Agencies, in coordination with NMFS, to evaluate delayed mortality of transported versus nontransported fish.

Action 186: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for comparative evaluations of the behavior and survival of transported and downstream migrants to determine whether causes of D can be identified for the reach between Bonneville Dam and the mouth of the Columbia River.

In addition to further refining estimates of D, investigations are needed to determine if delayed mortality occurs between Bonneville Dam and the mouth of the Columbia River. Differences in estuarine passage timing, behavior, survival, susceptibility to bird predation, and ocean entry timing should be evaluated to determine whether any delayed mortality occurs before ocean entry. Studies linking timing of transport release to passage past predatory bird colonies in the estuary should be conducted. Timing barge releases to pass the bulk of the fish past the bird colonies when birds are not actively feeding might significantly reduce estuarine mortality, particularly for steelhead. Methodologies could include PIT-tag deployments and radio and sonic tracking. This study should be coordinated with other behavioral studies of smolts in the estuary and nearshore ocean.

Action 187: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies and analyses to evaluate relationships between ocean entry timing and SARs for transported and downstream migrants.

Limited data from transportation studies indicate that adult return rates for transported and downstream migrants can vary greatly by season, by week, and perhaps by day. In general, adult return rates of transported fish are lower for fish moved during the early portion of the outmigration, but return rates can increase substantially for fish transported later. Inriver migrant return trends are the opposite, starting out high and decreasing throughout the season. Understanding the causes of these variations could lead to improved adult returns by relating the effects of fish transport or nontransport to fish condition or to the physical and biological environment of the Columbia River plume at the time of ocean entry. Linking ocean entry timing to conditions at the time of entry would improve NMFS' understanding of aspects of the plume environment that influence early ocean survival. This could lead to better management practices that would improve survival rates, such as smolt entry timing and flow volume.

Action 188: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies of PIT-tagged wild stocks from the lower river streams. The studies shall be used to contrast stock productivity and hydrosystem effects.

Schaller et al. (1999) conclude that differences in productivity between upstream and downstream stocks are due to the number of dams through which each stock must pass. Comparing the outmigration timing, physiology, health, and condition of PIT-tagged wild fish from systems such as the John Day River with PIT-tagged wild fish from the Snake River in ongoing studies would enable comparisons between the two groups and assessment of similarities and differences.

Action 189: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to investigate the causes of discrepancies in adult return rates for juvenile salmonids that have different passage histories through the hydrosystem.

Adult returns from 1995 through 1998 indicate that SARs for smolts that have passed through the hydrosystem vary by year, number of juvenile bypass systems encountered, and specific bypass system, when compared with juveniles that were never detected when passing through the hydrosystem. To date, this is the only empirical evidence of delayed mortality associated with inriver passage through the hydrosystem. In general, SARs decreased as the number of bypass passages increased. These data suggest that juvenile bypass systems may affect adult return rates. In addition, return rates for fish that passed only through Lower Granite Dam are similar to those never detected in the hydrosystem, suggesting that individual bypass systems treat fish differently. This could be caused by a number of factors, including poor outfall locations, increased stress, reduced fitness associated with passage through mechanical components of the systems (such as separators and the PIT tag detection systems), and the tendency for mechanical screen guidance efficiency to increase for fish with BKD. Studies relating the passage histories of individual smolts to changes in physiological parameters, behavioral responses, and survival rates are needed to determine the causes for the observed SARs and identify potential solutions. Furthermore, experimental management of the hydrosystem should be considered to address discrepancies in adult returns associated with passage history. These experiments might include pulling all screens at a dam to eliminate passage through bypass systems, or routing fish directly to outfall sites with full bypass flow so that little to no dewatering occurs.

Action 190: The Action Agencies shall continue to fund studies that monitor survival, growth, and other early life history attributes of Snake River wild juvenile fall chinook.

The Action Agencies, in coordination with NMFS through the annual planning process, will continue to provide funding to monitor wild juvenile fall chinook survival, growth, and other early life attributes. Knowledge of wild fish survival, migration timing, and growth rates is critical as a baseline comparison for studies involving juvenile hatchery fall chinook used as surrogates for wild fish. Supplementation of juvenile fall chinook above Lower Granite Dam is, in addition, resulting in increased parr densities. At some point, decreased growth may occur, affecting the survival of wild fish.

9.6.5.3.5.2 Adult Monitoring and Evaluation

The adult monitoring enhancements in this section are intended to improve basic knowledge about upstream passage survival. They complement and enhance the more specific studies to evaluate and improve adult upstream passage survival called for in Section 9.6.1.6.

Action 191: The Action Agencies shall continue to implement adult salmonid counting programs at FCRPS dams, but shall improve the reporting of these counts.

In addition to the daily counts already provided, the Action Agencies will work through FPOM to improve reporting of winter passage counts for all projects where winter counting currently occurs. These counts will be reported in the same manner as other in-season counts (except that 3-day updates will be acceptable). These changes in reporting methods will be implemented no later than the winter 2000-2001 adult migration. Prespawn, summer-run steelhead are abundant near McNary Dam during the late fall and early winter months. Fallback through the juvenile bypass system at McNary can exceed 50 steelhead per day before screen removal on December 15 (P. Wagner, Washington Department of Fish and Wildlife, pers. comm.). Large concentrations of steelhead have also been observed in late fall near John Day Dam, and adult steelhead are known to pass Bonneville Dam all winter. The reporting requirements described above are designed to provide the level of information needed for decision-making during both normal and emergency fish passage management and consultation, especially during the winter maintenance period.

Action 192: As set out in Action 50 (Section 9.6.1.3.4), BPA and the Corps shall install necessary adult PIT-tag detectors at appropriate FCRPS projects before the expected return of adult salmon from the 2001 juvenile outmigration. These adult PIT-tag detectors shall be used as needed for calculating transport benefits, conversion rates, and SARs for listed salmon and steelhead.

This action, set out in RPA 49 (Section 9.6.1.3.4), is repeated here because it is an important part of the system-wide research, monitoring, and evaluation program. The ability to enumerate PIT-tagged adult salmon and steelhead will allow more accurate assessments of critical adult passage information, including conversion rates between dams, steelhead kelt survival rates, travel time, and fallback rates with minimal adult handling mortality. This will enable making estimates of SAR transport and other survival studies specified in this biological opinion. Coordination of the schedule for installing adult PIT-tag detectors at FCRPS projects is necessary to ensure that the various studies requiring adult PIT-tag detection capability can be implemented in a timely manner.

Action 193: The Action Agencies shall investigate state-of-the-art, novel fish detection and tagging techniques for use, if warranted, in long-term research, monitoring, and evaluation efforts.

Fish tagging, detection, and tracking technologies suitable for use in assessing juvenile and adult salmonid survival, behavior, and distribution are limited. Key components of this tagging effort are as follows:

- The need to discriminate between hatchery and wild fish (not all hatchery fish are currently marked)
- The ability to differentiate populations and their use of different ocean productivity zones
- The ability to determine growth and survival characteristics based on population, location, and oceanographic characteristics

Development of new technologies may enhance opportunities to conduct necessary research, monitoring, and evaluation activities identified in this biological opinion. Development and application of new technologies should be coordinated with other entities to take into account needs across all life stages of salmonids.

9.6.5.3.6 Hydropower, Tier 3—Monitoring Effects of Hydropower Operations on Estuarine and Early Ocean Habitat

An important, but often overlooked, aspect of the biology of Columbia River basin salmonids is the effect of the FCRPS on their use of estuarine and ocean (plume and nearshore) environments. The FCRPS can have a direct and substantial impact on conditions in these habitats through its alteration of the hydrograph, water quality, and other impacts. Regional analyses have identified these environments as critical to population growth potential and, thus, as appropriate for mitigation actions.

Unfortunately, little is known about salmonid use of these habitats. Of primary importance are the following:

- The contribution of juvenile survival during the estuary/early ocean phase to overall ocean survival

- Cause-and-effect links between estuary/early ocean resources and juvenile survival

- Cause-and-effect links between estuary/ocean resources and adult survival

- The spatial distribution of each stock in the estuary/ocean and the temporal contribution to survival

- The influence of natural variation versus that of humanly caused changes in environmental conditions affecting juvenile and adult survival in the estuary/ocean phase

The distribution of each stock in the estuary/early ocean, survival rates, and natural variation in those rates will largely be addressed through tier 2 population and environmental status monitoring. However, tier 3 studies will be necessary to determine causal links between FCRPS alterations of the estuarine and nearshore ocean environments and salmon population response. In addition, several important studies addressing the following are also needed:

- Enhance and benchmark plume modeling; establish a long-term plume monitoring station.

- Partition the role of the estuary habitat from that of the nearshore ocean in juvenile survival.

- Identify and differentiate physical/chemical versus biological factors that cause mortality.

- Evaluate the influence of altering volume and timing of the historical hydrograph, hydrosystem operations, and the physical condition (bathymetry and structure) of the lower Columbia River and the estuary, as well as the effect on juveniles of the size, shape, and beneficial use of the Columbia River plume in the nearshore ocean environment.

- Determine the extent of indirect, humanly caused mortality in these environments; for example, assess how tern and cormorant populations are affected by hatchery and hydrosystem operations.

To address these critical needs, the following ongoing activities will be conducted:

Action 194: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to develop a physical model of the lower Columbia River and plume. This model will characterize potential changes to estuarine habitat associated with modified hydrosystem flows and the effects of altered flows where they meet the California Current to form the Columbia River plume.

Physical characteristics of the estuary such as river flow, hydrograph, velocity, bathymetry, salinity intrusion, and circulation patterns define estuarine conditions. It is, therefore, important to characterize the physical aspects of the estuary and to compare existing and future physical attributes with historical conditions to assess the potential effect of hydrosystem flow regimes on estuarine habitat. Physical changes to the estuary will affect its ecology and, potentially, how salmonids use the estuary for migration, growth, and development. The plume habitat as an extension of the estuary, or as a unique habitat important to Columbia River salmon, will be similarly affected by actions of the FCRPS. Characterization of these effects to assess the importance of historical and current conditions will help facilitate the recovery of all salmon stocks.

Action 195: The Action Agencies shall investigate and partition the causes of mortality below Bonneville Dam after juvenile salmonid passage through the FCRPS.

A long-term research, monitoring, and evaluation plan should be developed to measure mortality that may occur after smolts have passed through Bonneville Dam. The plan will include post-Bonneville mortality that may be associated with passage of smolts through the Federal hydrosystem and the extent of delayed mortality, which is uncertain and central to decisions about hydrosystem configuration and the role of juvenile salmonid transportation. These evaluations should attempt to establish how much of the post-Bonneville mortality is natural and how much is related to other factors, such as hydrosystem passage and fitness.

Action 196: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to develop an understanding of juvenile and adult salmon use of the Columbia River estuary. These studies support the actions to develop criteria for estuarine restoration (Action 158), restoration planning (Action 159), and implementation (Action 160) in Section 9.6.2.2.

Estuary use potentially has a major effect on salmonid survival to adulthood. The estuarine ecology of salmon in general and the use of Columbia River estuarine habitat in particular are poorly understood. Juvenile distributions relative to habitat type, food habits, prey preferences, and the growth and physiological condition of juveniles entering and leaving the estuary are important aspects of salmonid ecology in the estuary. Information on these aspects of all salmonid life histories is needed to develop an understanding of salmonid estuary use and any influences of the hydrosystem on flows, turbidity, and nutrient delivery that might, in turn, affect salmonid ecology in the estuary.

Action 197: The Action Agencies and NMFS shall work within the annual planning and congressional appropriation processes to establish and provide the appropriate level of FCRPS funding for studies to develop an understanding of juvenile and adult salmon use of the Columbia River plume.

Plume dynamics and interaction with the California Current can potentially have a major effect on salmonid survival to adulthood. The plume ecology of salmon and use of the plume habitat are poorly understood. Juvenile distribution in terms of food availability, predators, and performance (fitness, growth, and health) must be assessed in relation to plume dynamics. Information on all salmonid life histories is needed to develop an understanding of salmonid use of the plume and any influences of the hydrosystem on turbidity, nutrient delivery, and habitat attributes that might affect salmonid ecology and survival in the plume.

Evaluating juvenile and adult use of the estuarine and nearshore environments will require monitoring techniques still in the early phases of development. In particular, the use of acoustic (sonic) tags with fixed, towed, or buoyed detector arrays is recommended, as is the continued development of existing technologies such as PIT-tag detector flowthrough trawl surveys. The immediate value of a concerted sampling effort in the estuary and nearshore regions will be development of cause-and-effect relationships between FCRPS flow management and physical conditions (e.g., bathymetry, suspended particulate matter, and temperature) that affect the availability of suitable habitat for juvenile salmonids. NMFS will use this information to recommend changes in flow management operations to improve juvenile survival.

9.6.5.4 Data Management

Action 198: The Action Agencies, in coordination with NMFS, USFWS, and other Federal agencies, NWPPC, states, and Tribes, shall develop a common data management system for fish populations, water quality, and habitat data.

The application of performance standards and measures and the use of offsite mitigation as partial compensation for unavoidable hydrosystem effects will require additional data collection and analysis. Validation of the approach, and of the specific actions taken, will require continual confirmation that these measures are sufficient to avoid jeopardy and facilitate recovery of listed salmonids. Evaluations of actions taken, the feasibility of future actions, and factors affecting mortality will depend on the availability of scientifically defensible findings. Development and implementation of offsite mitigation will require close coordination with relevant state actions such as water management and water quality compliance mechanisms. It will also require close coordination with Federal land managers and EPA. NMFS' past year of work on the CRI analysis has focused the need for a single comprehensive system to ensure integration of monitoring and evaluation information described in this section with information from other sources. This includes, but is not limited to, requirements described in other sections of this biological opinion.

9.6.5.5 ESA Section 10 Permit Authorization for Research/Monitoring Pursuant to the RPA

Scientific research and monitoring are critical parts of the overall program to minimize take of ESA-listed anadromous fish species resulting from the operation of mainstem FCRPS projects on the Columbia and Snake rivers. These activities are necessary to satisfy elements of the RPA described in individual subsections. In addition, specific terms and conditions related to research and monitoring efforts are proposed for inclusion in the incidental take statement of this biological opinion. The required research/monitoring activities will provide data and information necessary to develop annual management strategies to help mitigate hydropower system impacts and to answer important questions related to system operations. Special project operations for required research/monitoring activities that deviate from normal operations described in the Corps' Fish Passage Plan will, however, continue to be coordinated with interested parties through the annual planning process and in subsequent ESA-related coordination with NMFS.

The identified scientific research/monitoring activities are only a subset of the activities that will be funded by the Action Agencies, primarily BPA and the Corps. Those agencies are also responsible for complying with Section 7 of the ESA because they fund activities that may affect threatened or endangered species or designated critical habitat. To streamline the permitting process and avoid delaying critical research, monitoring, and evaluation measures, this biological opinion considers the effects of the activities that would be funded and will fulfill each individual Action Agency's Section 7 consultation requirement. Not all activities are included, because not all are well-enough defined to identify the proposed methods and, from that, the estimated levels of take. As new study plans are developed in accordance with this RPA, NMFS anticipates the need for additional Section 10 research permits.

While some research/monitoring activities associated with the RPA cannot be determined in sufficient detail until annual plans are prepared and approved, the following describes specific research activities that can be anticipated now, based on the elements of the RPA described in Section 9.6.1.

Action 199: The Action Agencies shall implement the specific research/monitoring actions outlined in Appendix H.

9.7 ANALYSIS OF EFFECTS

The effects of the RPA are evaluated with respect to action-area biological requirements in Section 9.7.1 and with respect to species-level biological requirements in Section 9.7.2. These sections parallel those used to evaluate the proposed action in Section 6. Additionally, in Section 9.7.3, the effects of the RPA are compared to effects that would probably occur as a result of breaching four Snake River dams. This comparison is included because dam breaching is an alternative that was specified for consideration in the 1995 FCRPS Biological Opinion, and it is the main alternative to the RPA that the Federal agencies have considered (Corps 1999c). It is also included because Section 9.5 describes breaching as a likely alternative action if the status of stocks has declined and/or the RPA is not as effective as expected, when assessed through the mid-point evaluation process. This analysis supports the elements of the RPA that require continued engineering and other preparations for possible future breaching.

9.7.1 Effects of RPA Measures on Action-Area Biological Requirements

As in Section 6.2, NMFS first evaluates the effects of the RPA within the action area. Effects are evaluated with respect to juvenile passage survival, adult passage survival, transportation, and various aspects of critical habitat within the action area.

9.7.1.1 Juvenile Salmonid Passage

Juvenile passage routing and survival are evaluated with respect to the various routes of passage at FCRPS dams. This section emphasizes changes from the proposed action that are expected from implementation of the RPA.

9.7.1.1.1 Turbine Units. Significant numbers of listed juvenile salmonids will continue to pass through FCRPS powerhouse turbines even with the relatively high proportion of fish passage through alternative routes (e.g., spill, bypass systems, and transportation). Previous FCRPS Biological Opinions (1995 and 1998) have required operation of turbines within guidelines that are expected to reduce mortality of juvenile migrants passing through turbines. These opinions also required investigations of juvenile and adult turbine passage mortality and investigation of turbine designs that reduce this mortality. Evaluation of a new turbine design using a minimum gap runner at Bonneville Dam has indicated a small but positive improvement (0 to 3%) in juvenile passage survival compared to the older runner design. These results are preliminary, and future evaluations are necessary before survival improvements can be statistically quantified.

This RPA calls for research to answer these questions. In addition, this RPA includes the following:

1. Investigations to improve fish survival in the tailrace

2. Examination of the potential fish survival benefits of operating minimum gap runner turbine units at or beyond the current guidelines of turbine operation established to maximize fish survival

3. Removal of unnecessary obstructions in the high-velocity areas of the turbine

4. Periodic index testing of turbine families to ensure that the operating guidelines reflect current conditions

These studies will provide better understanding of the complicated interaction between fish survival and turbine design and operation. This knowledge will probably lead to improved turbine design and operation to benefit fish survival. Considering the information available to date, NMFS expects that installation of minimum gap runners at the Bonneville Dam First Powerhouse would produce a 2% improvement in turbine survival at that project. Therefore, juvenile passage survival through the turbines at Bonneville First Powerhouse is expected to increase for both yearling spring and subyearling summer and steelhead migrants from 90%, under the current action (Appendix D, Tables D-1 to D-3), to 92% under the RPA (Appendix D, Tables D-4 to D-6).

9.7.1.1.2 Bypass Systems. The RPA is expected to increase FGE and bypass system survival at many of the FCRPS dams. The following section lists the expected increases at each dam for yearling spring migrants and subyearling summer migrants. The values estimated under the current configuration and operations can be found in Appendix D, Tables D-1 to D-3. The passage estimates expected under implementation of the RPA measures that were used in the SIMPAS passage survival modeling are shown in Appendix D, Tables D-4 to D-6.

Lower Granite Dam. Yearling and subyearling chinook and steelhead survival rates are expected to increase from 98% under the current action to 99% under the RPA, with juvenile fish bypass improvements.

Lower Monumental Dam. Yearling chinook FGE is expected to increase from 49% under the current action to 78% under the RPA with installation of extended-length intake screens and new vertical barrier screens. Bypass survival would increase from 95% to 98% with juvenile fish bypass improvements and outfall relocation. Subyearling FGE would increase from 49% to 56% with installation of extended-length intake screens and new vertical barrier screens. Steelhead FGE would increase from 82% to 84%.

McNary Dam. Yearling and subyearling chinook and steelhead bypass survival is expected to increase from 98% under the current action to 99% under the RPA with juvenile fish bypass improvements.

John Day Dam. Yearling chinook FGE is expected to increase from 73% under the current action to 82% under the RPA with installation of extended-length intake screens and new vertical barrier screens. Subyearling FGE is expected to increase from 32% to 60% with installation of extended-length intake screens and new vertical barrier screens. Steelhead FGE is expected to increase from 85% to 94%.

Bonneville First Powerhouse. Yearling FGE is expected to increase from 39% under the current action to 72% under the RPA with installation of extended-length intake screens. Bypass survival is expected to increase from 90% to 98% with juvenile fish bypass improvements. Subyearling FGE is expected to improve from 9% to 35% with installation of extended-length intake screens. Bypass survival would increase from 82% to 98% with juvenile fish bypass improvements. Steelhead FGE is expected to improve from 41% to 85%. Bypass survival would increase from 90% to 98%.

Bonneville Second Powerhouse. Yearling FGE is expected to increase from 48% under the current action to 60% under the RPA, with improved intake flows and screen performance. Subyearling FGE is expected to increase from 28% to 40% with improved intake flows and screen performance. Steelhead FGE is expected to increase from 48% to 60% under the RPA.

9.7.1.1.3 Spillway and Sluiceway Systems. In several ways, the RPA improves the current juvenile fish passage spill program, as defined in the 1995 FCRPS Biological Opinion and the 1998 Supplemental FCRPS Biological Opinion. The RPA includes:

- Implementation of 24-hour spill at Lower Monumental Dam
- Evaluation of 24-hour spill at John Day Dam
- Evaluation of raising the daytime spill cap at Bonneville Dam
- Reduction of 24-hour spill at The Dalles Dam

The evaluations at John Day, The Dalles, and Bonneville dams may lead to additional changes in the spill program as the study results are assessed and implemented. These changes may occur as early as the 2002 spill season, but may be limited by transmission system constraints that will be addressed no later than 2005. These changes are expected to improve inriver survival of all juvenile salmon migrants by reducing passage through turbines. Decreased predation is also anticipated as a result of reduced juvenile residence time in predator-rich forebays. In the case of The Dalles Dam, immediate survival benefits are expected as a result of spill reduction. Lower amounts of spill combined with improved spill patterns are expected to help reduce physical injury and predation in the river immediately below the spillway.

The FCRPS fish passage spill program improvements included in the RPA are estimated to result in a systemwide inriver survival rate increase of approximately 4% and 1% for yearling and subyearling migrants, respectively. These values represent a relative increase of 8% and 10% over the existing system inriver survival rate as estimated for each respective chinook stock.

These estimated survival rate improvements do not include further spill increases made possible through additional or modified spillway deflectors, nor do they include pool survival increases that may result when migrants spend less time in project forebays as a result of 24-hour spill. The greatest portion of the survival rate increase expected as a result of the RPA spill changes is expected at The Dalles Dam, where spill passage survival is estimated to increase approximately 8% to10%.

New structural measures to pass juveniles in surface water are under development at several FCRPS dams. These surface bypass efforts are expected to increase spill efficiency, reduce stress related to dam passage, and potentially reduce dissolved gas supersaturation levels. Increased spill efficiency means that water spilled for fish passage is more efficiently used or, in other words, more fish are passed per unit volume of water. Stress and delay are reduced when fish use surface routes through dams. Fish pass more readily through direct surface routes, whereas passage through deeper routes takes them longer. Reducing delays in forebays reduces juvenile exposure to predators. Reduction in predation and passage stress is expected to increase survival.

Current FCRPS project pool mortality estimates were reduced by 10% in the SIMPAS model runs under RPA conditions (Table 9.7-1) in order to characterize this expected survival increase. The expected 10% reduction in pool mortality is primarily based on reduced exposure of smolts to predators, both from project operations and predator control programs. This expected benefit is further explained in Section 9.7.1.5 below.

9.7.1.2 Adult Salmonid Passage

The RPA calls for a number of actions to better assess the effect of passage through the FCRPS hydropower system on adults and their spawning success, better account for adult losses, and identify and implement measures to reduce adult delays, injuries, and mortalities related to FCRPS passage. Aging adult fishway facilities will be updated, and spare parts for critical components will be procured to ensure proper operations during the passage season and avoid injurious facility failures. The identification and implementation of structural and operational measures are expected to reduce inadvertent adult fallback and related mortalities. For those adults that intentionally fall back, including downstream migrating adult steelhead kelts, identification and implementation of corrective operations and facilities will increase their survival. Identification of the cause of adult headburn will lead to corrective measures to reduce this source of injury to spring/summer chinook salmon. Potential benefits, including reduced water temperature, reduced passage delays, and improved gamete viability, for SR steelhead and fall chinook may be identified through the evaluation of Dworshak Reservoir cold water releases in September.

Table 9.7-1. Project and system survival of transported juvenile SR spring/summer and fall chinook salmon and steelhead outmigrants[1] under the RPA.

YEAR	LGR	LGS	LMN	IHR	MCN	JDA	TDA	BON	% Inriver Survival (LGR to BON)	% Inriver Survival (MCN to BON)	Prop. ESU Transported	% Total System Survival	% Total System Survival with D	
	Project Survival (% Dam + Pool Survival)													
SR spring/summer chinook salmon													D= 0.63	D= 0.73
1994	94.7	84.4	88.6	89.8	87.5	79.8	91.1	86.8	35.1	55.2	90.9	89.5	56.5	65.4
1995	91.7	89.0	95.1	94.0	94.5	87.0	93.6	90.9	51.1	70.0	43.4	67.7	52.0	56.2
1996	97.8	92.9	95.5	88.1	88.5	86.3	92.8	90.4	48.9	64.0	58.0	75.5	54.5	60.2
1997	92.4	94.4	92.5	90.1	90.4	85.1	91.7	89.5	45.9	63.2	51.7	69.9	51.1	56.2
1998	93.5	98.3	88.6	95.9	96.4	84.3	94.1	91.8	54.7	70.2	50.3	73.7	55.5	60.4
1999	94.9	95.1	95.1	95.3	95.9	87.1	95.7	94.7	61.9	75.7	51.8	77.9	59.1	64.2
6-YR Avg.	94.2	92.3	92.6	92.2	92.2	84.9	93.2	90.7	49.6	66.4	57.7	75.7	54.8	60.4
SR fall chinook salmon													D=0.24	
1994	No data collected in 1994.													
1995	69.9	89.5	81.4	88.8	83.7	77.4	89.6	85.1	22.4	49.4	62.8	62.3	15.6	
1996	52.8	90.3	79.8	88.4	84.1	76.2	89.2	84.4	16.2	48.3	47.1	46.9	11.8	
1997	41.4	60.4	67.5	66.9	58.8	40.8	71.7	57.4	1.1	9.9	31.7	31.1	7.5	
1998	60.0	78.8	92.4	88.8	84.3	77.3	89.6	85.0	19.2	49.6	52.2	51.9	13.0	

Table 9.7-1 (continued). Project and system survival of transported juvenile SR spring/summer and fall chinook salmon and steelhead outmigrants[1] under the RPA.

YEAR	Project Survival (% DAM + Pool Survival) LGR	LGS	LMN	IHR	MCN	JDA	TDA	BON	% Inriver Survival (LGR to BON)	% Inriver Survival (MCN to BON)	Prop. ESU Transported	% Total System Survival	% Total System Survival with D	
1999	78.9	69.3	89.6	82.1	76.5	64.4	84.4	76.1	12.7	31.6	64.7	64.0	15.8	
5-YR Avg.	60.6	77.7	82.1	83.0	77.5	67.2	84.9	77.6	14.3	37.7	51.7	51.2	12.7	
SR steelhead													D= 0.52	D= 0.58
1994	91.4	87.6	93.6	91.6	89.7	83.3	92.3	89.0	42.1	61.3	89.9	88.3	46.0	51.3
1995	95.1	91.6	97.8	93.2	93.6	89.8	94.5	92.7	58.4	73.6	48.4	74.8	52.1	55.0
1996	94.2	95.1	96.6	89.9	90.2	87.6	93.1	91.3	52.3	67.2	59.3	76.8	48.9	52.4
1997	96.8	97.7	93.6	92.0	92.2	86.8	92.3	90.7	54.6	67.0	58.1	78.3	51.0	54.4
1998	93.5	94.5	92.4	90.2	90.6	85.0	96.1	95.5	51.9	70.6	52.1	73.0	48.4	51.5
1999	91.9	94.1	94.7	92.0	92.3	93.1	90.6	85.6	50.2	66.6	52.2	71.8	47.3	50.3
6-YR Avg.	93.8	93.4	94.8	91.5	91.4	87.6	93.1	90.8	51.6	67.7	60.0	77.2	49.0	52.5

[1] A range (1994 to 1999) of flow conditions was estimated using NMFS' spreadsheet model (SIMPAS). Values shown are estimates, based on juvenile survival studies rather than adult returns, and representing performance of mixed (wild + hatchery) runs. Spring/summer chinook salmon are yearling migrants; fall chinook salmon are subyearling migrants. Details on how these survival estimates were developed can be found in Appendix D.

Corrective measures at all the FCRPS projects which significantly reduce inadvertent fallback and the mortality associated with fallback through turbines are expected to increase the survival of all listed salmonid species that originate above Bonneville Dam. The analyses in the RPA concerning fallback, Subsection 9.6.1.6.2, estimate that with corrective measures spring/summer chinook and steelhead direct passage survival to Lower Granite Dam could increase by about 0.5%, while Snake River fall chinook direct passage survival could increase by 7%. Increased passage delay is also associated with fallback. Keefer and Bjornn (1999) reported that the median dam passage time for all seven dams studied in 1996 was higher for spring/summer chinook salmon that fell back at a dam one or more times. Conceivably, indirect delayed mortality and diminished spawning success could result from increased passage times due to fallback.

Corrective measures that significantly reduce the incidence of headburn could conceivably increase the survival of SR spring/summer chinook and UCR spring chinook by as much as 2% on average (see analyses in the RPA, Subsection 9.6.1.6.2).

A preliminary estimate of steelhead kelt abundance in the Lower Snake River in 2000 was 16,745 (Evans and Beaty 2000), which is approximately 22% of the total count of steelhead that passed upstream of Lower Granite Dam in 1999. The RPA requires studies to identify and implement measures to increase the survival of kelts so that the rate of repeat spawners will improve. Reconditioning, downstream transport, and reduced turbine entrainment passage alternatives will be evaluated.

Information from adult passage studies was used in the RPA analyses in Subsection 9.6.1.6.2 to arrive at preliminary estimates of 27% (1991) and 9% (1993) for spring/summer chinook salmon adult loss between Lower Granite Dam and the spawning ground or hatchery. While further studies will be needed to resolve the accuracy and determine the cause of these preliminary estimates, the significance of these loss estimates to recovery prospects cannot be overstated. Furthermore, mere arrival at the spawning ground does not guarantee spawning success. If spawning success is diminished during upstream passage, these adult loss estimates are conservative. Adult loss and diminished spawning success above Lower Granite Dam could be due to any number of causes suggested in the RPA, including delays, injuries, and elevated water temperatures experienced during passage through the FCRPS dams, or perhaps predation, illegal harvest, gillnet interactions, and disease. The RPA expects to better account for the sources of adult loss above Lower Granite Dam and downstream, assess spawning success, and implement identified measures to increase adult survival and reproduction.

Based on the foregoing reasoning and analyses, the RPA measures are expected to increase minimum survival estimates by at least 3% over the current condition minimum survival rates listed in Table 6.1-1 for SR spring/summer chinook, fall chinook, and steelhead that pass through eight FCRPS dams. For those species passing through four or fewer FCRPS dams, the expected survival increase from implementing the RPA is scaled down according to the number of dams. For example, for UCR steelhead and spring chinook that pass through four FCRPS dams, the

RPA measures are expected to increase the current minimum survival rate by at least 1.5%. For those species that pass only through Bonneville Dam, such as LCR steelhead and spring chinook, the expected survival rate increase is at least 0.5%. Table 9.7-2 summarizes the estimated minimal survival rates under current conditions and those expected under the RPA for the listed species. In addition to the increased passage survival rate, the RPA expects to identify, quantify, and reduce indirect mortality and diminished spawning success that may be due to passage through the FCRPS projects.

9.7.1.3 Water Regulation and Impoundments

BPA assessed the effects of water management measures specified in Section 9.6.1.2 using its Hydrosim hydroregulation model. The Hydrosim model simulates operations at the FCRPS and other Columbia basin projects to meet an array of purposes including flood control, anadromous and resident fish protection, projected energy loads, Columbia basin Treaty obligations, and other project-specific, non-power requirements. Hydrosim simulates operations for 14 time steps each year (10 months plus two time steps each for April and August) over a 50-year (August 1929 to July 1978) hydrologic record. Outputs of interest to NMFS include mean monthly discharge at various locations and end-of-month reservoir elevations for the major storage projects. A summer (June 30) reservoir refill priority was assumed in the modeling.

This approach to estimating the outcomes of alternative project operations implies that hydrologic conditions recorded in the past are reasonable estimates of future conditions. Hydrologic conditions are highly variable. The longer the historical period of record used, the more likely the simulation will capture the range of future conditions likely to occur. Although there is growing evidence that the earth's climate is changing, it is unlikely that such changes would substantially violate the assumption that future hydrologic conditions will be similar to past conditions during the 10 years this biological opinion will be in effect.

The base case model run placed priority on meeting the reservoir operating provisions specified in NMFS' 1995 and 1998 FCRPS Biological Opinions and USFWS' 1995 Biological Opinion on Kootenai River sturgeon. A summary of the base case (proposed action) model results are shown in Table 6.2-5. Subsequent modeling scenarios evaluated the effects of including VARQ and modified flood control curves, providing deeper reservoir drafts at selected FCRPS projects, and increasing the Mica and/or Revelstoke project's discharge during the summer period. Model output consisted of 50-year monthly flows at various projects and a summary of the effect of project operations by enumerating the frequency with which the NMFS flow objectives are met on a monthly and seasonal basis at Lower Granite, Priest Rapids, McNary, and Bonneville dams. The effect of flow operations on the frequency of storage reservoirs achieving upper (flood control) rule curve on April 10 and refill by June 30 was also summarized. Table 9.7-3 summarizes operational criteria for the hydrosystem regulation study representing foreseeable RPA water management actions in the next 4 to 5 years.

Table 9.7-2. Estimates of minimum adult survival and unaccounted loss based on radio-tracking studies through the FCRPS projects.

	Multi-Year Radio-Tracking Studies		Single Year Reach Studies			Current Condition				RPA Condition	
	1995 BiOp	1998 BiOp	RT 96[1]	RT 97[1]	RT 98[1]	Mean Loss[2]	Minimum Mean Survival[3]	Number of Dams	Per-Project Survival[4]	Minimum Mean Survival[11]	Per-Project Survival
Chinook Salmon											
SR spr/sum chinook	0.209[5]	0.252	0.161	0.158	0.130	0.175	0.825	8	0.976	0.855	0.981
SR fall chinook	0.393				0.187	0.290	0.710	8	0.958	0.740	0.963
UCR spr chinook[6]							0.907	4	0.976	0.922	0.981
LCR spr chinook[6]							0.976	1	0.976	0.981	0.981
LCR fall chinook[7]							0.958	1	0.958	0.963	0.963
Steelhead											
SR steelhead		0.208	0.270	0.204		0.227	0.773	8	0.968	0.803	0.973
UCR steelhead[8]							0.878	4	0.968	0.893	0.973
MCR steelhead[8]							0.878	4	0.968	0.893	0.973
LCR steelhead[8]							0.968	1	0.968	0.973	0.973
SR sockeye salmon	0.154[9]			0.132[10]		0.143	0.857	8	0.981	0.887	0.985

[1] T. Bjornn, pers. comm., November 2000 (data from 1996, 1997 and 1998 radio-tracking studies).
[2] Average of 1995 and 1998 Biological Opinion and radio-tracking studies.
[3] 1 minus mean loss.
[4] Calculated by taking the 8th root of the eight dam minimum mean survival estimates.
[5] Not included in loss/survival estimates (1998 Biological Opinion estimate is an update of the 1995 Biological Opinion estimate).
[6] Calculated from SR spring/summer chinook salmon per-project survival rates.
[7] Calculated from SR fall chinook salmon per-project survival rates.
[8] Calculated from SR steelhead per-project survival rates.
[9] Based on count analyses (1985 to 1994) (1995 Biological Opinion).
[10] Sockeye passage to Wells Dam.
[11] Minimum mean survival for RPA condition is 3% higher than current condition for SR species passing through eight projects, 1.5% higher for species passing through four projects, and 0.5% higher for species passing only through Bonneville Dam.

Table 9.7-3. Summary of criteria for hydrosystem regulation study of RPA actions (Study 00FHS33wo).

Criteria added to base case (00fsh30) operations
1. Additional Grand Coulee draft in low water years (to elev. 1,280 feet if Apr to Aug runoff ≥92 Maf and to elev. 1,278 feet if Apr to Aug runoff < 92 Maf).
2. Banks Lake–reduced storage of 5 feet–water returned when most convenient for power and fishery purposes.
3. 2000 Biological Opinion spill levels.
4. VARQ flood control operation at Libby and Hungry Horse dams and USFWS minimum flows (with sliding scale minimum flows at Hungry Horse).
5. Albeni Falls is operated to elevation 2,051 feet from November through April.
6. Fall spawning flows below Bonneville Dam.

9.7.1.3.1 Probability of Achieving NMFS Flow Objectives. Table 9.7-4 provides a summary of the percent of years flows at Lower Granite, Priest Rapids, McNary, and Bonneville dams expected to meet or exceed NMFS flow objectives under the RPA. In comparing the results of Table 9.7-4 to Table 6.2-5, there are little or no changes to monthly flows at Lower Granite Dam. In general, Snake River flows meet or exceed NMFS flow objectives during the spring migration except in the lowest 20 water years. In the summer months, NMFS flow objectives are not achieved in the Snake River except in the highest 10 water years.

At McNary Dam on the Columbia River, there is little or no change in meeting NMFS flow objectives under the RPA compared to current operations in the months of April, May, July, and August. However, there is a 6% increase in achieving the flow objective under the RPA during June, from 50% to 56%. Similarly, the 135 kcfs spring flow objective at Priest Rapids Dam is exceeded in 90% of the years in June, compared to 78% under current operations, a 12% increase. Under the RPA operation, the spring seasonal flow objective is achieved 88% of the time, while the 200 kcfs seasonal flow objective in the summer is exceeded 28% of the time at McNary Dam.

Fall and winter flows at Bonneville Dam for LCR chinook and CR chum salmon spawning and incubation through emergence were also evaluated. A flow objective of at least 125 kcfs was achieved in November in 74% of the years under both the RPA and the proposed action, compared to only 30% if Albeni Falls is held at elevation 2,055 feet for a kokanee spawning evaluation. This flow objective was achieved in 90% of the years in December, a similar frequency as under the proposed action. In January through March, the flow objective was also met with a similar frequency under the RPA as under the proposed action, e.g., 76% to 86% during this period.

Table 9.7-4. Percent of years flows at Lower Granite, Priest Rapids, McNary, and Bonneville dams are expected to meet or exceed specified flow objectives under RPA based on 50-year continuous hydrosystem simulation (1929 through 1978).

Period	Project			
	Lower Granite	Priest Rapids	McNary	Bonneville
January	N/A	N/A	N/A	86
February	N/A	N/A	N/A	78
March	N/A	N/A	N/A	76
April	38	58	48	N/A
May	60	84	64	N/A
June	68	90	56	N/A
July	40	N/A	46	N/A
August	0	N/A	10	N/A
September	N/A	N/A	N/A	10
October	N/A	N/A	N/A	20
November	N/A	N/A	N/A	74
December	N/A	N/A	N/A	90

Source: BPA Hydrosim Run 0Y00.00FSH28.OPER.

9.7.1.3.2 FCRPS Reservoir Effects. Based on the results of BPA's hydrosystem modeling, effects on FCRPS storage reservoir operations under the RPA compared to the proposed action (base case) are summarized below.

Grand Coulee. The 50-year hydrosystem study results indicate the RPA-proposed draft of an additional 2 feet below elevation 1,280 in years when the April-to-August forecast is less than 92 Maf does not affect either 1) refill probability in subsequent years, or 2) the project's ability to achieve elevation 1,283 or above by the end of September (see Section 9.6.1.2.3 for a description of Grand Coulee operations). For example, the modeling results for the RPA operation indicate that FDR Lake refills or reaches its upper rule curve elevation on June 30 in all 50 water years, and the project has a 50-year average elevation of 1,283.5 feet by the end of September. In addition, the 50-year average draft of Grand Coulee reservoir by August 31 is to elevation 1,279.5 feet.

Banks Lake and Columbia Basin Project Pumping. Under the RPA operation, pumping from FDR Lake into Banks Lake is reduced in August by an equivalent volume of the top 5 feet (127 kaf) of storage in Banks Lake in years when this water is needed to meet the McNary Dam flow objective (see Section 9.6.1.2.4 for a description of Banks Lake operations). Additional water is pumped from FDR Lake in the following January-April period to return Banks Lake elevation to its original elevation.

Libby. Libby Reservoir either refills or reaches its upper rule curve elevation by June 30 in 16 years (32%) under the RPA operation as under the proposed action operation (see Section

9.6.1.2.3 for a description of Libby operations). In addition, the 50-year average draft of Libby reservoir at the end of August is elevation 2,442 feet under the RPA operation, as compared to elevation 2,439 feet under the proposed action. At the end of August, the reservoir refills in 2 years under the RPA compared to no years under the proposed action.

Hungry Horse. Hungry Horse Reservoir either refills or reaches its upper rule curve elevation on June 30 in 7 more years, 34 years versus 27 years, in the RPA operation than under the proposed action (see Section 9.6.1.2.3 for a description of Hungry Horse operations). Under both the RPA and the proposed action, the 50-year average draft of Hungry Horse Reservoir at the end of August is 3,543 feet. In addition, the reservoir elevation is between 3,550 feet and 3,560 (full pool) feet on August 31 in 5 years under the RPA, as opposed to 4 years under the proposed action.

Albeni Falls. Except for the USFWS kokanee spawning evaluation during the next 6 years, the RPA operates the Albeni Falls project to elevation 2051 feet during October through April of each year to assist in meeting chum salmon flow needs in the lower Columbia River (see Section 9.6.1.2.3 for a description of Albeni Falls operations).

Dworshak. In the RPA operation as in the proposed action, Dworshak drafts to elevation 1520 feet by the end of August of each year, if needed to support Lower Granite Dam flow objectives and water temperature control (see Section 9.6.1.2.3 for a description of Dworshak operations). In September, the RPA also proposes to draft the project an additional volume of 244 kaf, but no lower than elevation 1,500 feet, to reduce temperature and to meet flow objectives in the lower Snake River as part of an adult fish passage evaluation (see Section 9.6.1.2.6 for a description of Dworshak's September temperature and adult passage evaluation operation). A 50-year hydroregulation study of Dworshak refill probability indicates the September adult study operation, when it is conducted, would have little effect on reservoir refill by the end of June in subsequent years, i.e., there are only two additional refill failures at Dworshak on June 30, and the average of these three refill misses is less than 12 feet from full pool, with two of these misses within 9 feet of full pool. For comparison, the single refill miss under the proposed action was 15 feet from full pool.

9.7.1.4 Water Quality

Gas abatement measures in the RPA will reduce TDG levels and thereby improve water quality and reduce the risk to listed salmonids. Installation of flow deflectors at Chief Joseph Dam will reduce gas entrainment and TDG levels downstream during spill periods at that project. This measure will improve water quality conditions for UCR spring chinook and steelhead adults and juveniles downstream of Chief Joseph Dam. It will also help ensure that spill programs for passage of juvenile UCR spring chinook and steelhead at Wells, Rocky Reach, and Rock Island dams are not affected by elevated gas levels originating at Chief Joseph.

The deflector optimization program at the lower Snake and lower Columbia FCRPS projects will improve water quality and reduce gas entrainment during voluntary juvenile fish passage spill and during involuntary spill periods.

Temperature reduction measures identified in the RPA will help reduce elevated water temperature conditions in the lower Snake River and in fish bypass facilities to improve migration conditions and survival rates of subyearling fall chinook. For example, modifications to water supply intake facilities at Dworshak National Fish Hatchery would eliminate the current operating restrictions on releases of cooler water from Dworshak Reservoir, which would allow for flow volume increases and lower water temperatures in the lower Snake River to improve migratory conditions for summer migrating juvenile fall chinook. Hatchery supply water that is cooler than 54°F (12°C) has been shown to negatively affect the growth of juvenile fish reared at the hatchery. When the required modifications to the hatchery water supply system are completed, it will be possible to augment Snake River flows using Dworshak discharges with temperatures as low as 48°F (9°C), providing a greater cooling effect downstream.

Thermal-related stress is known to contribute to juvenile fish collection mortality at McNary Dam. Hydrothermal computational fluid dynamics (CFD) modeling has the potential to provide quantitative information that would enable the Corps, NMFS, and fishery comanagers to determine the physical effects on water temperature of selected project operation and/or structural modifications at McNary Dam. CFD modeling could help evaluate the potential ability of alternative powerhouse operations to decrease the inflow of elevated summertime water temperatures into gatewells, the juvenile fish collection channel, and raceways.

9.7.1.5 Effects of Predator Control

Improvements in predator control include improvements to the Northern Pikeminnow Management Program and evaluations of avian and marine mammal predation near and above Bonneville Dam. These evaluations may lead to actions that can be implemented to reduce predation. The direct effects of these predator control efforts on juvenile survival are difficult to quantify. However, on the basis of information in the Predation White Paper (NMFS 2000f), NMFS estimates that implementing the RPA measures will reduce FCRPS project pool mortalities of both yearling and subyearling juveniles by an average of approximately 10%. Accordingly, NMFS applied the 10% average reduction in the SIMPAS model.

To illustrate: estimated mortality for yearling spring/summer chinook in John Day Reservoir is approximately 12% (Table 6.2-8). A 10% reduction in mortality would therefore be an absolute change of 1.2%. The White Paper cites an estimate that approximately 7.3% of all juvenile salmonids entering John Day Reservoir annually are lost to northern pikeminnow predation. Table 10 of the White Paper lists model predictions for the expected reduction in the pikeminnow predation rate due to continuation of the predation control program. At John Day, for the years 2000 to 2006, the model estimates that the predation rate will be reduced by approximately 9% annually. Reducing the estimated current pikeminnow predation loss of 7.3% by 9% gives an approximate 0.66% annual reduction in pool mortality due to the predator control program alone. This is about half of the 10% (1.2% absolute) assumed in the RPA analysis.

Other measures in the RPA, such as spill operations and future surface passage facilities, are all expected to further reduce delay at the dam, and therefore exposure to predators. In addition, measures to reduce mortalities due to other piscine and avian predators will also reduce pool mortality rates. Although the pool mortality reduction rate expected from these other measures cannot be quantified at this time, it appears reasonable to expect that these measures, when combined with the reduction expected from the pikeminnow control program, will be sufficient to result in a 10% reduction in pool mortality.

9.7.1.6 Juvenile Transportation Program

9.7.1.6.1 Percentage of Each Species Transported. Under the RPA, the proportion of the SR mixed stock yearling chinook population potentially collected and transported from the three Snake River collector dams is estimated to average about 58%, with a range from 43% to 91% depending on river conditions. For summer migrating SR fall chinook, the proportion transported is lower than that for yearling chinook because of significant mortality that occurs before these fish first reach Lower Granite Dam. The proportion of fall chinook potentially collected and transported is estimated to average about 52%, with a range from 32% to 65% depending on river conditions. Similar estimates for SR steelhead average 60%, with a range from 48% to 90% (Table 9.7-1).

9.7.1.6.2 Survival Benefits to Each Species. Without transportation, the average inriver survival of combined mixed stock SR yearling chinook salmon from Lower Granite Dam to below Bonneville Dam is estimated to be nearly 50%, with a range from 35% to 62% depending on river conditions. With transportation, combined transport and inriver survival to below Bonneville Dam is estimated to be about 76%, with a range from 68% to 90%. For summer migrating SR fall chinook, the proportion of the population surviving to below Bonneville Dam without transportation is estimated to be about 14%, with a range from about 1% to 22%. With transportation, the proportion of the population surviving to below Bonneville Dam is about 51%, with a range from 31% to 64%. Similar estimates for SR steelhead average almost 52% without transportation (range 42% to 58%), and 77% (range 72% to 88%) with transport (Table 9.7-1).

9.7.1.6.3 Effects of Extended Barging Season. This measure addresses the concerns of the Independent Scientific Advisory Board and others in the region regarding potential adverse effects on juvenile fish that are transported by truck as compared to barging. Collected juveniles that migrate early and late in the season have been transported by truck for release below Bonneville Dam. Unlike the summer migrants, which are trucked, all of the early transported migrants are released from the shoreline at selected locations thought to afford the best available release conditions (strong downstream current, deep water in close proximity, no avian predators). Due to safety concerns, trucked fish are routinely released during daylight, a period when avian predators are most active. In contrast, barged fish are released at various midriver locations under more favorable hydraulic conditions where predators have less opportunity to forage.

9.7.1.6.4 Potential Release of Trucked Fish from New Bonneville Juvenile Fish Bypass Outfall. As described above, juvenile fish that are trucked at the beginning of the season are released from the shoreline, where there is increased likelihood of consumption by predators. The new Bonneville juvenile fish bypass outfall was sited to afford bypassed fish a higher survival rate. If the post-construction evaluation of the new outfall does not show any problems, there should be a survival advantage for trucked fish released from that location.

9.7.1.6.5 Transportation from McNary Dam. The potential benefits to listed Upper Columbia species are unknown. Transportation around the remaining three lower Columbia dams would avoid FCRPS-related mortality in that reach and thereby increase their relative survival. On the other hand, collection and transportation from McNary may result in indirect mortality. Evaluations of transport benefits conducted during the 1980s relied on juvenile fish collected by sampling from the juvenile facility. Those fish were most likely a mix of upper Columbia and Snake River fish.

Currently, transport barges from the lower Snake River bypass the McNary Dam juvenile facility and arrive below Bonneville earlier than would otherwise occur. More barged fish are released in daylight instead of after dark, which was the case before transport was suspended.

More juvenile salmon and steelhead that migrate in June would remain inriver to complete their migration if the decision to initiate transportation is based on a daily average riverflow and water temperature criteria. In the past 2 years, collection and transport began when inriver migratory conditions were more favorable to their survival through the lower Columbia River. Because spring migrant transport operations at McNary will continue to be suspended until new studies demonstrate positive benefits, there is no scientific basis for transporting summer migrants passing the project under springlike conditions. Available data do not show a transport benefit for summer migrants transported during the early portion of the migration, and only a slight benefit for the middle segment of the run. Studies in the 1980s were conducted when fish-handling facilities and practices were less favorable than they are now, and the mainstem dams were operated without juvenile fish protection considerations. Future evaluations are desirable to help determine whether summer migrants should be removed from the river under good inriver migratory conditions.

Installation of adult PIT-tag detectors in main fishways at McNary Dam will allow collection of adult return data without any handling. These facilities are essential to conduct transport research at McNary.

9.7.1.6.6 Improvements to Transportation Program. Planning transport operations at the dams so that fish are released from specific areas at specific times to enhance their post-release survival has the potential to reduce estuarine-related predation. At present, fish barges at the uppermost dam are loaded on the day shift in the morning. That schedule determines the barge loading schedule at the downriver projects. No consideration is given to the optimum times that fish would need to be released below Bonneville to ensure the survival rate. Staff resource and safety issues are the primary considerations. Researchers have speculated that survival at the saltwater interface may be higher if transported fish arrive at the estuary concurrent with an outgoing tide. This could reduce delay and potential negative interactions with avian predators (i.e., at Rice Island).

9.7.1.6.7 NMFS' Issuance of Section 10 Permits for Juvenile Transportation Program and Smolt Monitoring Program. The juvenile transportation program is an integral component of the proposed action in this biological opinion. The Corps' existing permit expires on December 31, 2000. Issuance of a new Section 10 permit for the transportation program will be necessary for 2001 and beyond. Effects of bypass and collection of smolts on SR steelhead, UCR steelhead, and SR spring/summer chinook survival are described in Section 6.2.3. Effects of adult fallback through bypass systems are assessed in Section 6.2.4. Effects of transportation, in terms of direct survival to below Bonneville Dam and relative survival to adulthood compared to inriver migrants, are discussed in Section 6.2.8. Biological information regarding all aspects of the transportation program and its effect on listed steelhead and salmon is included in the Transportation White Paper (NMFS 2000i).

The smolt monitoring program is also an integral component of the current action. Issuance of the Section 10 permit for the smolt monitoring program is also necessary for 2001 and beyond (see Appendix H).

9.7.1.7 Summary: Effects of RPA on Juvenile and Adult Survival

The information in Table 9.7-5 summarizes the effects of the RPA on the listed salmon and steelhead juvenile survival rates, estimated using the SIMPAS model, and minimum adult survival rates, estimated from radio-tag study results and listed in Table 9.7-2. Also included in Table 9.7-5, for comparison purposes, are summaries of the effects of the current action on juvenile survival rates, estimated using the SIMPAS model and listed in Appendix D, Tables D-1 through D-3. Minimum adult survival rates, estimated from radio-tag study results, are listed in Table 6.1-1.

Table 9.7-5. Summary of estimated effects of the RPA in the action area.

ESU	Estimated Inriver Juvenile Survival through FCRPS		Estimated Inriver and Transport Juvenile Survival With D through FCRPS		Estimated Adult Survival through FCRPS	
	Current	RPA	Current	RPA	Current	RPA
Chinook Salmon						
SR spr/sum chinook (D = 0.63-0.73)	0.27-0.52	0.35-0.62	0.50-0.64	0.51-0.65	0.83	0.86
SR fall chinook (D = 0.24)	0.005-0.16	0.01-0.22	0.06-0.15	0.08-0.16	0.71	0.74
UCR spring chinook	0.46-0.66	0.55-0.76	N/A	N/A	0.91	0.92
UWR chinook	N/A	N/A	N/A	N/A	N/A	N/A
LCR chinook-spring	0.83-0.91	0.87-0.95	N/A	N/A	0.97	0.98
LCR chinook-fall	0.50-0.80	0.57-0.85	N/A	N/A	0.96	0.96
Steelhead						
SR steelhead (D = 0.52-0.56)	0.32-0.46	0.42-0.58	0.45-0.52	0.46-0.55	0.77	0.80
UCR steelhead	0.57-0.64	0.61-0.74	N/A	N/A	0.88	0.89
MCR steelhead	0.57-0.64	0.61-0.74	N/A	N/A	0.88	0.89
UWR steelhead	N/A	N/A	N/A	N/A	N/A	N/A
LCR steelhead	0.85-0.92	0.86-0.96	N/A	N/A	0.97	0.97
CR chum salmon	0.50-0.80	0.57-0.85	N/A	N/A	0.96	0.96
SR sockeye salmon	N/A	N/A	N/A	N/A	0.86	0.89

9.7.2 Analysis of Effects of Proposed Action on Biological Requirements Over Full Life Cycle

Appendix C describes the median annual population growth rate (lambda) and the risk of absolute extinction at the ESU and, in some cases, the population level. In this section, NMFS looks at the likely effects of the proposed action on the risk of extinction and likelihood of recovery (Section 1.3.1.1 and 6.1.2). Although the jeopardy standard is ultimately a qualitative assessment of whether there is a high likelihood of survival with an adequate potential for recovery, NMFS considers the specific level of improvement needed to achieve particular risk levels as one indication of population status relative to that jeopardy standard (Sections 1.3.1.1 and 6.1.2). These risk levels ($\leq$5% risk of extinction in 24 and 100 years; $\geq$50% likelihood of meeting interim recovery abundance levels in 48 and 100 years; $\geq$50% likelihood that population growth rate will be stable or increasing) are referred to subsequently as “survival indicator criteria” or “recovery indicator criteria.” This standardized analysis is used to evaluate the importance of the effects described in the preceding section, as likely to occur in the action area in the context of the full life cycle. The data for some of the ESUs considered in this biological opinion are too scarce or are not of adequate quality to permit a quantitative life-cycle analysis of this type. For some of those ESUs, inferences can be drawn from the quantitative results described for the other ESUs.

Details of the quantitative analyses used to evaluate the effects of the proposed action on biological requirements over the full life cycle are described in Section 6.1.2 and Appendix A. Quantitative and qualitative estimates are summarized for several ESUs in the following sections.

9.7.2.1 Snake River Spring/Summer Chinook Salmon

Evaluation of species-level effects of the RPA requires placing the action-area effects in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of SR spring/summer chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range, including habitat degradation in many areas due to timber harvest, grazing, and mining practices (loss of pools, high temperatures, low flows, poor overwintering conditions, and high sediment loads).

In this section, NMFS evaluates quantitatively the action-area effects associated with the hydrosystem component of the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions are sufficient to change annual population growth rates such that survival and recovery are likely.

9.7.2.1.1 Populations Evaluated

NMFS evaluated 43 spawning aggregations of SR spring/summer chinook salmon. Seven of these are the "index stocks" described in the June 27, 2000, draft biological opinion, previous NMFS analyses (McClure et al. 2000b), and PATH reports (Marmorek et al. 1998). The remaining spawning aggregations were the subject of new analyses in McClure et al. (2000c). NMFS has not yet determined which, if any, of the index stocks and additional spawning aggregations represent populations, as defined by McElhany et al. (2000), but all are treated as independent populations because of the statistical assumptions inherent in the analysis.

9.7.2.1.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria. NMFS also estimated the change from the base period lambda necessary to achieve ≥50% likelihood of meeting interim recovery abundance levels (NMFS 1995c) in 48 and 100 years using the most current estimates of lambda and methods described in Appendix A. Interim recovery abundance levels have only been defined for three ESUs and, in the SR spring/summer chinook ESU, only for the seven index stocks. Therefore, NMFS estimated the change in lambda necessary to meet an alternative recovery indicator criterion of lambda ≥1.0 (Appendix A) for all other spawning aggregations. Details of each of these estimates are included in Appendix A.

NMFS also investigated the effects of adding preliminary returns in 2000 and an estimate of expected returns in 2001 (based on jack abundance) to the time-series used to estimate lambda in each of the calculations described above. Estimates are included in McClure (2000b). These preliminary returns were included in the lowest estimates of necessary survival changes.

9.7.2.1.3 Expected Survival Change

The necessary improvements in population growth rate described above are based on the assumption that life-stage survival rates influencing adult returns from 1980 to 1999 will continue indefinitely. However, in Section 6.3.1.3, NMFS estimates that current survival represents a 24%-to-32% improvement over the average survival rate influencing base period adult returns. The range represents two methods of estimating survival change. One relies entirely on PATH results, and the other relies on a combination of PATH and SIMPAS model estimates (Section 6.3.1.3). Implementing the hydrosystem component of the RPA will proportionally increase adult survival beyond the current level by an additional 3.7%, based on information in Table 9.7-5. The hydrosystem component of the RPA will also increase juvenile survival to below Bonneville Dam, including differential post-Bonneville survival of transported fish (D) of 63% to 73%, by approximately 1% (Table 9.7-5). The product of the proportional survival improvements associated with the current conditions and the RPA results in an expected survival improvement of 30% to 38% (1.30 to 1.38 times the average base period survival rate), as described in Appendix A.

No other quantifiable survival rates changed significantly between the average base period condition and the current condition. NMFS was unable to quantitatively estimate possible changes in egg-to-smolt survival, estuary survival, and adult survival above Lower Granite Dam that may have resulted from habitat and hatchery management actions, so no change in those survival rates is included in this quantitative analysis. In Section 9.7.2.1.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.1.4 Additional Necessary Survival Changes

Table 9.7-6 shows the effect of the 30% to 38% survival rate increase expected from the hydrosystem component of the RPA on the future median annual population growth rates for 43 SR spring/summer chinook spawning aggregations. In some cases (e.g., Marsh Creek), the resulting population growth rate is expected to change from a declining trend (lambda <1.0) to a stable or increasing trend. In spite of the expected improvement in population growth rate, at least 22, and possibly as many as 25, of the 43 spawning aggregations require additional survival improvements to meet the survival and recovery indicator criteria. Table 9.7-6 displays the additional improvements in survival that would be necessary, beyond the 30% to 38% improvement associated with the RPA, to reduce the 100-year extinction risk to 5% and either increase the likelihood of recovery in 48 years to 50% or increase the likelihood of achieving a stable or increasing population growth rate to 50%. These indicator criteria were presented because, if they are achieved, all the survival and recovery indicator criteria will be achieved.

Values in Table 9.7-6 less than or equal to 1.0 indicate that no further survival improvements are necessary to meet the survival and recovery indicator criteria. Values greater than 1.0 represent the multiplier by which survival would have to improve to achieve these criteria. For example, the survival change necessary to reduce the risk of extinction in 100 years to 5% (columns 8 and 9 of Table 9.7-6) is 0.85 to 1.05 for the Sulphur Creek index stock. This means that the RPA, combined with expected survival in other life stages (see Section 9.7.2.1.6, below), is sufficient to reduce the 100-year extinction risk to 5% or less under the highest estimate of the expected survival change and the lowest estimate of the needed improvement. On the other hand, under the lowest estimate of the expected survival change and the highest estimate of the needed survival change, an additional 5% survival improvement (1.05 times expected survival rate) is necessary. This means that an additional 5% increase in egg-to-adult survival, or any component life-stage-specific survival rate, would be necessary to achieve no more than a 5% risk of extinction in 100 years for this index stock under the most pessimistic assumptions evaluated by NMFS.

Table 9.7-6. Snake River spring/summer chinook estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing RPA.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		*Additional Change In Survival Needed to Achieve:* 5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.82	0.91	1.30	1.38	0.86	0.98	1.46	1.56	1.12	1.89
Index Stocks:										
Bear Valley/Elk Creeks	1.02	1.03	1.30	1.38	1.07	1.10	0.72	0.77	0.79	0.89
Imnaha River	0.88	0.92	1.30	1.38	0.93	0.99	0.84	1.16	1.26	1.66
Johnson Creek	1.01	1.03	1.30	1.38	1.07	1.11	0.72	0.77	0.70	0.83
Marsh Creek	0.99	1.00	1.30	1.38	1.04	1.07	0.74	0.89	0.98	1.12
Minam River	0.93	1.02	1.30	1.38	0.99	1.10	0.72	1.13	0.84	1.28
Poverty Flats	0.99	1.02	1.30	1.38	1.05	1.11	0.72	0.77	0.73	0.90
Sulphur Creek	1.04	1.05	1.30	1.38	1.10	1.13	0.85	1.05	0.78	0.87
Additional Aggregations:										
Alturas Lake Ck	0.75	0.75	1.30	1.38	0.79	0.80	N/A	N/A	2.68	2.86
American R	0.91	0.91	1.30	1.38	0.96	0.98	N/A	N/A	1.11	1.19
Big Sheep Ck	0.85	0.88	1.30	1.38	0.90	0.92	N/A	N/A	1.29	1.58
Beaver Cr	0.95	0.95	1.30	1.38	1.01	1.02	N/A	N/A	0.90	0.96
Bushy Fork	0.98	0.98	1.30	1.38	1.04	1.05	N/A	N/A	0.79	0.84
Camas Cr	0.92	0.92	1.30	1.38	0.98	0.99	N/A	N/A	1.04	1.11
Cape Horn Cr	1.05	1.05	1.30	1.38	1.12	1.13	N/A	N/A	0.58	0.61
Catherine Ck	0.78	0.85	1.30	1.38	0.83	0.84	N/A	N/A	1.50	2.31
Catherine Ck N Fk	0.92	0.92	1.30	1.38	0.98	0.99	N/A	N/A	1.04	1.12
Catherine Ck S Fk	0.80	0.80	1.30	1.38	0.84	0.86	N/A	N/A	2.01	2.14
Crooked Fork	1.00	1.00	1.30	1.38	1.06	1.07	N/A	N/A	0.73	0.78
Grande Ronde R	0.77	0.84	1.30	1.38	0.82	0.83	N/A	N/A	1.58	2.42
Knapp Cr	0.89	0.89	1.30	1.38	0.94	0.96	N/A	N/A	1.22	1.30
Lake Cr	1.06	1.06	1.30	1.38	1.12	1.14	N/A	N/A	0.56	0.60
Lemhi R	0.98	0.98	1.30	1.38	1.03	1.05	N/A	N/A	0.81	0.86
Lookingglass Ck	0.72	0.79	1.30	1.38	0.77	0.78	N/A	N/A	2.02	3.25
Loon Ck	1.00	1.00	1.30	1.38	1.06	1.08	N/A	N/A	0.71	0.76
Lostine Ck	0.87	0.90	1.30	1.38	0.92	0.94	N/A	N/A	1.15	1.44
Lower Salmon R	0.92	0.92	1.30	1.38	0.97	0.99	N/A	N/A	1.07	1.14
Lower Valley Ck	0.92	0.92	1.30	1.38	0.98	0.99	N/A	N/A	1.03	1.10
Moose Ck	0.94	0.94	1.30	1.38	1.00	1.02	N/A	N/A	0.93	1.00
Newsome Ck	1.03	1.03	1.30	1.38	1.09	1.10	N/A	N/A	0.64	0.68
Red R	0.91	0.91	1.30	1.38	0.96	0.98	N/A	N/A	1.10	1.18
Salmon R E Fk	0.94	0.94	1.30	1.38	1.00	1.01	N/A	N/A	0.96	1.02
Salmon R S Fk	1.06	1.06	1.30	1.38	1.12	1.14	N/A	N/A	0.56	0.60
Secesh R	0.98	0.98	1.30	1.38	1.03	1.05	N/A	N/A	0.80	0.86
Selway R	0.91	0.91	1.30	1.38	0.97	0.98	N/A	N/A	1.08	1.15
Sheep Cr	0.80	0.80	1.30	1.38	0.85	0.86	N/A	N/A	1.97	2.10
Upper Big Ck	0.97	0.97	1.30	1.38	1.03	1.04	N/A	N/A	0.87	0.89
Upper Salmon R	0.90	0.90	1.30	1.38	0.96	0.97	N/A	N/A	1.13	1.21
Upper Valley Ck	1.03	1.03	1.30	1.38	1.09	1.11	N/A	N/A	0.63	0.67
Wallowa Ck	0.86	0.86	1.30	1.38	0.91	0.92	N/A	N/A	1.42	1.51
Wenaha R	0.84	0.90	1.30	1.38	0.89	0.91	N/A	N/A	1.14	1.66
Whitecap Ck	0.90	0.90	1.30	1.38	0.96	0.97	N/A	N/A	1.14	1.22
Yankee Fork	0.88	0.88	1.30	1.38	0.94	0.95	N/A	N/A	1.26	1.35
Yankee West Fk	0.99	0.99	1.30	1.38	1.05	1.06	N/A	N/A	0.76	0.81

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically, except for the Imnaha (50% as effective). For index stocks, it also includes preliminary 2000 and projected 2001 returns in time series used to estimate lambda.
[3] Low represents estimation of juvenile survival improvement based on a comparison of PATH retrospective and prospective (A2) results.
[4] High represents estimation of juvenile survival improvement based on a combination of PATH and SIMPAS results.
[5] Low represents the low 1980-to-1999 lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-1999 lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A, including preliminary 2000 and projected 2001 returns for index stocks) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A, including only final returns through 1999) divided by the low estimate of the expected survival improvement.

Three of the seven index stocks require no additional survival changes beyond those expected under the RPA to meet the survival and recovery indicator criteria. The other four index stocks require additional survival improvements ranging from 0% to 66%. For the additional spawning aggregations, data were insufficient for estimating extinction risk, and no interim recovery levels have yet been determined. For the spawning aggregations, the necessary survival change is that which will result in lambda of 1.0. Under all assumptions, 21 of the 36 spawning aggregations require additional survival changes, ranging from 3% to 239%. One additional spawning aggregation needs no additional survival change under the best-case assumptions that NMFS evaluated, but needs a 2% survival change under the worst-case assumptions. The remaining 14 spawning aggregations require no additional survival improvements under any of the assumptions evaluated.

These results are similar to those of PATH (Marmorek et al. 1998, Peters and Marmorek 2000), with respect to the need for additional survival improvements after the hydrosystem component of the RPA is implemented, in order to meet approximations of the survival and recovery indicator metrics. However, the magnitude of the necessary changes differs between the two approaches and among different PATH reports. Section 6.3.1.4 compares the NMFS and PATH analyses of modeling scenarios approximating the proposed action. Implementation of the hydrosystem RPA does not fundamentally change the discussion in that section. Briefly, PATH (Peters and Marmorek 2000) and NMFS generally estimate a similar range of extinction risk, and PATH (Marmorek et al. 1998) and NMFS results suggest that a relatively small survival improvement is necessary to meet the recovery indicator metric for the sixth-worst stock. However, the PATH experimental management analysis (Peters and Marmorek 2000) suggests that well over a 100% improvement in survival is needed for the worst stock to meet the recovery indicator metric.

9.7.2.1.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27 draft biological opinion, which is very similar to this analysis, produced an overly optimistic estimate of the RPA's ability to achieve survival and recovery indicator criteria. The substantial comments primarily questioned the estimates of hydrosystem survival associated with the RPA (addressed in Section 9.7.1), the method of estimating the expected proportional change in the juvenile survival rate from the average associated with base period returns (addressed in Section 6.3.1.3 in one new and one modified method of estimating the expected change), the assumption that the effectiveness of hatchery-origin spawners may have been as low as 20% of that of wild-origin spawners (addressed in Section 6.3.1.5), and the analytical assumption that all survival changes are achieved instantaneously. This last point is addressed below.

The simple analytical approach used in this biological opinion assumes that all survival changes are instantaneous (McClure et al. 2000c). To the extent that improvements are implemented gradually, the analysis underestimates the survival change that will ultimately be required. The magnitude of the additional change depends on the stock under consideration and the length of the delay. To demonstrate the effect of this assumption, NMFS evaluated a 10-year delay in implementing the hydrosystem component of the RPA and of achieving any survival improvements in other life stages (Appendix A). The analysis also assumed that there has been no change from average base period survival as a result of current hydrosystem operations (which NMFS estimates as a 24%-to-32% improvement in Section 6). Further, the survival changes associated with current operations are assumed not to occur for 10 years. NMFS applied this extremely pessimistic assumption to the Imnaha River stock, which is the SR spring/summer chinook stock requiring the greatest survival improvement. Given these assumptions, a 58% to 95% survival improvement would be necessary at the end of 10 years to meet the recovery indicator criteria. In contrast, the estimate from the present analysis is a survival improvement of 26% to 66%. NMFS considers that effect qualitatively in making a jeopardy determination.

This analysis also contains assumptions that may make the results overly pessimistic. Three of these are the analytical assumptions that all spawning aggregates behave as independent populations; that all supplementation programs cease immediately; and that background survival will continue as it has since 1980. These assumptions are discussed in detail in Section 6.3.5.

9.7.2.1.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-6 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for SR spring/summer chinook salmon. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival above Lower Granite Dam. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. The RPA also provides mechanisms for pursuing additional, more intensive, actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.2 Snake River Fall Chinook Salmon

Evaluation of species-level effects of the RPA requires placing the action-area effects in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of SR spring/summer chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. Specifically, almost all of the historical spawning habitat in the Snake River basin is blocked by the Hells Canyon Complex. Other irrigation and hydroelectric projects block access to habitat in tributaries to the Columbia River below Hells Canyon. Habitat quality is degraded by agricultural water withdrawals, grazing, vegetation management, and forestry and mining practices (lack of pools, high temperatures, low flows, poor overwintering conditions, and high sediment loads).

In this section, NMFS quantitatively evaluates the action-area effects associated with the hydrosystem component of the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions are sufficient to change annual population growth rates such that survival and recovery are likely.

9.7.2.2.1 Populations Evaluated

NMFS analyzed the single aggregate Snake River fall chinook population. The analysis was based on Lower Granite Dam counts, so it does not include spawning areas in the Tucannon River and in the mainstem below some Corps dams.

9.7.2.2.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria. NMFS also estimated the change from base period lambda necessary to achieve $\geq$50% likelihood of meeting the aggregate population interim recovery abundance level (based on NMFS 1995c; specifics in Appendix A) in 48 and 100 years using the most current estimates of lambda and methods described in Appendix A.

9.7.2.2.3 Expected Survival Change

The necessary improvements in population growth rate described above are based on the assumption that life-stage survival rates influencing adult returns from the base period will continue indefinitely. However, in Section 6.3.2.3, NMFS estimates that current survival represents a 31%-to-63% improvement over the average survival rate influencing base period adult returns. The range represents four methods of estimating the survival change. One estimate of the juvenile passage survival change relies entirely on PATH results, whereas the other relies on a combination of PATH and SIMPAS model estimates (Section 6.3.2.3). One estimate of the change in harvest rate relies on PATH estimates, whereas the other relies on a PSC model estimate. The lowest survival improvement results when both juvenile survival and harvest are estimated using only PATH results. The highest survival represents the combination of PATH and SIMPAS juvenile modeling and the PSC harvest modeling results.

Implementing the hydrosystem component of the RPA will proportionally increase adult survival beyond the current level by an additional 4.2%, based on information in Table 9.7-5. The hydrosystem component of the RPA will also increase juvenile survival to below Bonneville Dam, including an assumed differential post-Bonneville survival of transported fish (D) of 24% (Section 6.2.3.3) by approximately 9% (Table 9.7-5). The product of the proportional survival improvements associated with the current conditions and the RPA results in an expected survival improvement of 49% to 86.0% (1.49 to 1.86 times the average base period survival rate), as described in Appendix A.

No other quantifiable survival rates changed significantly between the average base period and the current condition. NMFS was unable to quantitatively estimate possible changes in egg-to-smolt survival, estuary survival, and adult survival above Lower Granite Dam that may have resulted from habitat and hatchery management actions, so no change in these survival rates is included in this quantitative analysis. In Section 9.7.2.2.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.2.4 Additional Necessary Survival Changes

Table 9.7-7 shows the effect of the 49%-to-86% increase in survival rate expected from the RPA on the future median annual population growth rates for the aggregate SR fall chinook population. The resulting population growth rate is expected to change from a declining trend (lambda <1.0) to a stable or increasing trend (lambda = 1.07) under the highest estimate of survival change. However, under the lowest estimate of improved survival, the population growth rate is still expected to decline. No additional survival improvements are necessary to meet the survival indicator criteria under any of the assumptions considered in this analysis. Nor are any additional survival improvements required to meet the recovery indicator criteria when the highest expected change in survival is coupled with the lowest estimate of the necessary survival improvement. However, an additional 44% survival change is required when the low estimate of the expected survival change is coupled with the highest estimate of the needed survival improvement.

The results of the NMFS Snake River fall chinook analysis for the hydrosystem component of the RPA are generally consistent with the PATH assessments of a similar action. Both assessments indicate that no additional survival changes are needed to meet alternative survival indicator criteria, given similar assumptions regarding annual climate/environmental variability, harvest rates, and differential mortality for transported smolts. However, both assessments

Table 9.7-7. Snake River fall chinook estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
Aggregate SR fall chinook	0.87	0.92	1.49	1.86	0.96	1.07	0.66	0.94	0.93	1.44

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] Low represents estimation of juvenile survival improvement based on PATH retrospective and prospective (A2) results and change in harvest rate based on PATH.
[4] High represents estimation of juvenile survival improvement based on a combination of PATH and SIMPAS and harvest rate change based on PSC modeling.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

indicate that additional survival improvements would be required to meet the 48-year recovery indicator criterion under the full range of assumptions considered in each analysis.

PATH evaluated an action (A2) that incorporated most of the elements of the hydrosystem component of the RPA with respect to SR fall chinook (Peters and Marmorek 2000). The action A2 incorporated the changes in hydropower operations called for in the 1995 FCRPS Biological Opinion. While it incorporates similar juvenile survival assumptions, the PATH analysis does not include the adult survival improvement anticipated from the RPA. PATH evaluated actions under a range of assumptions regarding post-Bonneville Dam differential delayed mortality of transported fish relative to nontransported fish (expressed as a differential survival factor D). The ability of action A2 to meet PATH survival and recovery criteria depended on the assumption regarding D. If D is relatively high or if it had improved substantially over base values, PATH projected that A2 would readily exceed survival and recovery criteria used in the assessments. Under the assumption that D has remained at approximately 20%, approximating the level used in the current NMFS analysis (see Section 6.2.3.3), action A2 was projected to meet survival criteria but to fall short of recovery targets. Specifically, the PATH analysis projected the mean likelihood of reaching recovery goals in 48 years as 34%, 16 percentage points below the 50% likelihood associated with the recovery indicator criterion.

9.7.2.2.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the RPA's ability to achieve survival and recovery indicator criteria. Most comments were not specific to SR fall chinook salmon, but many of the points raised for SR spring/summer chinook salmon may also apply to SR fall chinook salmon. Substantial comments primarily questioned 1) the estimates of hydrosystem survival associated with the RPA (addressed in Section 9.7.1), 2) the method of estimating the expected proportional change in the juvenile survival rate from the average associated with base period returns (addressed in Section 6.3.2.3 through introduction of one new and one modified method of estimating the expected change), 3) the method of estimating the change in harvest rate (addressed in Section 6.3.2.3 through introduction of one new and one modified method), 4) the assumption that the effectiveness of hatchery-origin spawners may have been as low as 20% that of wild-origin spawners (addressed in Section 6.3.2.3), and 5) the analytical assumption that all survival changes are achieved instantaneously. This last point is addressed below.

The simple analytical approach used in this biological opinion assumes that all survival changes are instantaneous (McClure et al. 2000c). To the extent that improvements are implemented gradually, the analysis underestimates the survival change that will ultimately be required. The magnitude of the additional change depends on the stock under consideration and the length of the delay. To demonstrate the effect of this assumption, NMFS evaluated a 10-year delay in implementing the hydrosystem component of the RPA and of achieving any survival improvements in other life stages (Appendix A). The analysis also assumed that there has been no change from average base period SR fall chinook survival as a result of current hydrosystem operations (which NMFS estimates as a 33%-to-64% improvement in Section 6). Further, the survival changes associated with current operations are assumed not to occur for 10 years. Given these assumptions, a 16%-to-69% survival improvement would be necessary at the end of 10 years to meet the recovery indicator criteria. In contrast, the estimate from the present analysis is a 0%-to-44% survival improvement. NMFS considers this effect qualitatively in making a jeopardy determination.

This analysis also contains assumptions that may make the results overly pessimistic. Two of these are the analytical assumptions that all supplementation programs cease immediately and that background survival will continue as it has since 1980. These assumptions are discussed in Section 6.3.2.5.

9.7.2.2.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-7 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for SR fall chinook salmon. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival above Lower Granite Dam. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA provides mechanisms for pursuing additional, more intensive, actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.3 Upper Columbia River Spring Chinook Salmon

Evaluation of species-level effects of the RPA requires placing the action-area effects in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of UCR spring chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. Chief Joseph Dam and Grand Coulee Dam prevent access to historical spawning grounds farther upstream. Local problems relate to irrigation diversions and hydroelectric development, as well as degraded riparian and instream habitat from urbanization and livestock grazing along riparian corridors.

In this section, NMFS quantitatively evaluates action-area effects associated with the hydrosystem component of the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions are sufficient to change annual population growth rates such that survival and recovery are likely.

9.7.2.3.1 Populations Evaluated

NMFS analyzed the three populations identified by Ford et al. (1999) as components of this ESU: the Wenatchee River population, the Methow River population, and the Entiat River population. Ford et al. (1999) identified interim recovery goals for each population and included the criterion that all three must meet these goals for delisting.

9.7.2.3.2 Necessary Survival Change

McClure et al. (2000b,c) and Cooney (2000) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria. Cooney (2000) and NMFS (Appendix A) also estimated the change from base period lambda necessary to achieve $\geq$50% likelihood of meeting the three population interim recovery abundance levels (Ford et al. 1999) in 48 and 100 years using the most current estimates of lambda and methods described in Appendix A. The CRI analytical approach (McClure et al. 2000b) and the QAR analytical approach (Cooney 2000) produce different estimates of needed survival changes for these populations. NMFS considers both approaches to have advantages and disadvantages and uses results from both to define a range of necessary survival change.

NMFS also investigated the effects of adding 1999-to-2000 preliminary and 2001 projected returns to the time-series used to estimate lambda in each of the calculations described above. The 2001 projections are based on recent jack counts. Estimates are included in McClure et al. (2000b) and Cooney (2000). These preliminary returns were included in the preliminary estimates are included in the lowest estimates of necessary survival changes.

9.7.2.3.3 Expected Survival Change

The necessary improvements in population growth rate described above are based on the assumption that life-stage survival rates influencing adult returns from 1980 to 1998 will continue indefinitely. However, the Basinwide Recovery Strategy identifies implementation of the Mid-Columbia HCP at five PUD projects as a probable element of recovery planning that is, therefore, included in the analysis, consistent with step 4 of the jeopardy analysis framework described in Section 1.3. The Basinwide Recovery Strategy estimates that this action will be implemented within 2 to 5 years. Cooney (2000, Table 20) estimates that implementing the HCP will improve survival 28% for the Wenatchee population, 40% for the Entiat population, and 49% for the Methow population.

In addition, in Section 6.3.3.3, NMFS estimates that current FCRPS hydrosystem survival, combined with implementation of the Mid-Columbia HCP, represents a 7%-to-41% improvement over the average survival rate influencing base period adult returns. The range represents different effects of the HCP on each population and a range of estimates of the historical differential post-Bonneville survival (D = 0.8 to D = 1.0) in years when fish were transported from McNary Dam. Implementing the hydrosystem component of the RPA will proportionally increase adult survival through the FCRPS projects beyond the current level by an additional 1.5%, based on information in Table 9.7-5. The hydrosystem component of the RPA is also expected to proportionally increase juvenile survival to below Bonneville Dam by 15.5% (Table 9.7-5; Appendix A). The product of the proportional survival improvements associated with the current conditions, implementation of the HCP, and implementation of the hydrosystem RPA results in an expected survival improvement of 25% to 65% (1.25 to 1.65 times the average base period survival rate), as described in Appendix A.

No other quantifiable survival rates changed significantly between the average base period and the current condition. NMFS was unable to quantitatively estimate possible changes in egg-to-smolt survival (other than those associated with the HCP; Cooney 2000), estuary survival, and adult survival above the upper dam that may have resulted from habitat and hatchery management actions, so no change in these survival rates is included in this quantitative analysis. In Section 9.7.2.3.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.3.4 Additional Necessary Survival Changes

Table 9.7-8 shows the effect of the 25%-to-65% survival rate increase expected from the proposed action on the future median annual population growth rates for the three UCR spring chinook populations. These effects vary according to whether the QAR analytical approach (Cooney 2000) or the CRI analytical approach (McClure et al. 2000c) is used to estimate the current population growth rate and the necessary change. The CRI approach indicates that the population growth rate will continue to be negative for all three populations after HCP implementation and continuation of the proposed action, except for the Methow River population under the highest expectation (lambda = 1.01). Additional survival improvements ranging from 32% to 178% (1.32 to 2.78 times the average base period survival rate) will be necessary to meet the recovery indicator criteria. The QAR approach yields slightly more optimistic results, indicating that at least one, and possibly all three populations (under most optimistic assumptions), will have positive growth rates after HCP implementation and continuation of the proposed action. However, additional survival improvements ranging from 24% to 116% (1.24 to 2.16 times the average base period survival rate) will be necessary to meet the recovery indicator criteria.

9.7.2.3.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the proposed action's ability to achieve survival and recovery indicator criteria. Most comments were not specific to, or in some cases relevant to, UCR spring chinook salmon. However, three comments of particular relevance were that NMFS should not assume that the Mid-Columbia HCP will be implemented and achieve its survival goals within the time described in the Basinwide Recovery Strategy; that the analysis is overly optimistic because it assumes that all survival changes are achieved instantaneously; and that the analysis is overly optimistic because NMFS rejected the assumption of 80% effectiveness of hatchery-origin natural spawners. As described in Section 6.3.3.5, NMFS considers the full range of hatchery spawner effectiveness in this biological opinion.

Table 9.7-8. Upper Columbia River spring chinook estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

							Additional Change In Survival Needed to Achieve:			
Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate - CRI	0.84	0.85	1.36	1.54	0.90	0.94	1.20	1.41	1.32	1.58
Methow River - QAR	0.90	0.90	1.46	1.65	0.98	1.14	0.80	0.91	1.24	1.41
Entiat River - QAR	0.89	0.89	1.37	1.55	0.96	0.99	1.01	1.15	1.36	1.55
Wenatchee R. - QAR	0.88	0.92	1.25	1.42	0.93	1.09	0.99	1.40	1.51	2.16
Methow River - CRI	0.85	0.89	1.46	1.65	0.93	1.01	1.29	1.66	1.32	1.90
Entiat River - CRI	0.81	0.89	1.37	1.55	0.88	0.99	0.98	1.66	1.32	2.19
Wenatchee R. - CRI	0.80	0.85	1.25	1.42	0.84	0.92	1.22	1.83	1.84	2.78

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically and inclusion of preliminary and projected returns through 2001 for CRI estimates.
[3] Low represents an estimate of juvenile survival improvement based on assumption of historical D=0.8 from McNary Dam.
[4] High represents an estimate of juvenile survival improvement based on assumption of historical D=1.0 from McNary Dam.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A, including preliminary 2000 and projected 2001 returns for all except Methow QAR and Entiat QAR) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A, including only final returns through 1999) divided by the low estimate of the expected survival improvement.

The first comment applies to implementation of the proposed Mid-Columbia HCP. CRITFC believes that anticipated HCP survival rates will not be achieved at all five PUD dams for at least 10 years because long-term gas-abatement projects are needed to achieve the necessary spill levels. NMFS agrees that there is some uncertainty about the exact schedule for achieving all survival improvements anticipated in the HCP, but the proposed HCP for the Chelan and Douglas PUDs and the draft EIS anticipate that the survival improvements will be achieved by the end of Phase I (2003). If this does not occur, it is reasonable to anticipate additional changes under the terms of the proposed HCP.

Regardless of the exact implementation schedule, the analysis described above does assume that HCP and hydrosystem RPA survival improvements are achieved immediately, which is not the case. NMFS conducted a sensitivity analysis on the effect of a 10-year delay in implementing *any* survival improvements over the base period average survival rate (Section 6.3.3.5; Appendix C). Under this worst-case scenario, the CRI estimate of necessary survival change for the Wenatchee population increases from the estimate in Table 9.7-8 (additional 84% to 178% change) to a 265% to 368% change (Appendix A). This extreme scenario is unlikely, since some improvements associated with the HCP have already been achieved, but NMFS considers the implications of delayed implementation qualitatively in reaching jeopardy conclusions for this ESU.

This analysis also contains assumptions that may make the results overly pessimistic. Two such assumptions are that all supplementation programs cease immediately, and that background survival will continue as it has since 1980. These assumptions are discussed in Section 6.3.3.5.

9.7.2.3.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include changes in survival in other life stages that result from habitat or hatchery management, other than effects anticipated in the HCP. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-8 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for UCR spring chinook salmon. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival above Lower Granite Dam. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. The RPA also provides mechanisms for pursuing additional, more intensive, actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.4 Upper Willamette River Chinook Salmon

Evaluation of the species-level effects of the RPA requires placing the action-area effects of the RPA in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of UWR chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include the loss of habitat due to inundation or blockages resulting from the construction of numerous tributary hydroelectric and irrigation facilities, and habitat degradation due to timber harvest, development (agricultural, municipal, and industrial), dam development, and river channelization and dredging. Many of these activities result in poor water quality, high sediment loads, altered thermal regimes, and a large reduction in available spawning and rearing habitat.

In this section, NMFS quantitatively evaluates the action-area effects associated with the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions could increase annual population growth rates such that survival and recovery are likely.

9.7.2.4.1 Populations Evaluated

NMFS quantitatively evaluated one spawning aggregation, the McKenzie River above Leaburg Dam. Adequate information was not available for similar analyses for additional spawning aggregations. NMFS has not yet determined which, if any, of the UWR chinook spawning aggregations represent populations, as defined by McElhany et al. (2000), but treating the McKenzie River aggregation as an independent population satisfies the statistical assumptions inherent in the analysis.

9.7.2.4.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria for the McKenzie River spawning aggregation. NMFS also estimated the change from base period lambda necessary to achieve ≥50% likelihood of meeting the recovery indicator criterion of lambda ≥1.0 for this spawning aggregation. Details of these estimates are provided in Appendix A.

9.7.2.4.3 Expected Survival Change

NMFS' calculation of the necessary survival change (improvement in population growth rate) for UWR chinook salmon, referenced above, assumes that the life-stage survival rates that influenced the base period adult returns will continue indefinitely. NMFS cannot identify any significant changes in survival rates under the RPA compared with those that influenced the base period adult returns, because survival changes due to implementing the proposed action can be quantified only for species that migrate past mainstem dams (which excludes UWR chinook salmon). NMFS was also unable to quantify potential changes in egg-to-smolt survival, estuary survival, or adult survival that may have resulted from recent or ongoing habitat and hatchery management actions. Instead, in Section 9.7.2.4.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.4.4 Additional Necessary Survival Changes

Table 9.7-9 shows that the RPA is not expected to increase the population survival rate; a negative median annual population growth rate is expected to continue for the UWR chinook spawning aggregation in the McKenzie River above Leaburg Dam. An additional survival improvement of from 9% to 65% (1.09 to 1.65 times the average base period survival rate) is needed to meet the extinction indicator criteria.

Table 9.7-9. Upper Willamette River chinook estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

							Additional Change In Survival Needed to Achieve:			
Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
McKenzie River above Leaburg Dam	0.90	0.99	1.00	1.00	0.90	0.99	1.09	1.65	1.05	1.59

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] No quantifiable change in survival is expected.
[4] No quantifiable change in survival is expected.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

9.7.2.4.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations noted that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the likelihood that the RPA would meet the survival and recovery indicator criteria. However, these comments were not specific to, or relevant to, UWR chinook salmon. In fact, this analysis contains assumptions that may make the results overly pessimistic. For example, NMFS assumes that all supplementation programs cease immediately, and that the background survival rate will continue as it has since 1980. These points are addressed in Section 6.3.1.5.

9.7.2.4.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include qualitative assessments of the effects of the RPA on survival below Bonneville Dam, or changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-9 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for UWR chinook salmon. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival (above Willamette Falls). The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA provides mechanisms for pursuing additional, more intensive actions within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.5 Lower Columbia River Chinook Salmon

Evaluation of the species-level effects of the RPA requires placing the action-area effects of the RPA in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of LCR chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include the impacts of timber harvest (altered riparian vegetation, unstable streambanks, and decreased habitat complexity), agricultural practices (channelization and loss of riparian vegetation), road construction, and urban and industrial development; dams on the Cowlitz, Lewis, (Big) White Salmon, Clackamas, Sandy, and Hood rivers, which block fish passage to historical spawning areas; residual effects of mudflows from the Mt. St. Helens eruption (1980), which significantly disrupted and degraded habitat in the South Fork Toutle and Green rivers – as did post-eruption dredging, diking, and bank protection works in the Cowlitz River (below its confluence with the Toutle River); hatchery programs, beginning in the 1870s, which released billions of fish, homogenizing stocks between subbasins and introducing others from outside the ESU such that most of the fall-run chinook salmon spawning today in the Lower Columbia River ESU are first-generation hatchery strays; and an average total exploitation rate on fall-run stocks from this ESU of 65% for the base period brood years (approximately 45% in the ocean and 20% in freshwater).

In this section, NMFS quantitatively evaluates the action-area effects associated with the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions could increase annual population growth rates such that survival and recovery are likely.

9.7.2.5.1 Populations Evaluated

NMFS quantitatively evaluated 20 spawning aggregations below Bonneville Dam. Adequate information was not available for similar analyses for spawning aggregations above Bonneville Dam. NMFS has not yet determined which, if any, of the LCR chinook salmon spawning aggregations represent populations, as defined by McElhany et al. (2000), but treating the 20 aggregations as independent populations satisfies the statistical assumptions inherent in the analysis.

9.7.2.5.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria for the 20 spawning aggregations of LCR chinook salmon. NMFS also estimated the change from base period lambda necessary to achieve ≥50% likelihood of meeting the recovery indicator criterion of lambda ≥1.0 for each aggregation. Details of these estimates are provided in Appendix A.

9.7.2.5.3 Expected Survival Change

NMFS' calculation of the needed survival change (improvement in population growth rate) for the 20 spawning aggregations of LCR chinook salmon referenced above assumes that the life-stage survival rates that influenced the base period adult returns will continue indefinitely. Although structural and operational modifications have been made to Bonneville Dam since 1980, none of the spawning aggregations for which NMFS could perform quantitative analyses passes this project. NMFS was also unable to quantify potential changes in egg-to-smolt or estuary survival that may have resulted from recent or ongoing habitat and hatchery management actions. Instead, in Section 9.7.2.5.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.5.4 Additional Necessary Survival Changes

Table 9.7-10 shows that the RPA is not expected to increase the survival rate of these 20 LCR chinook salmon spawning aggregations, all located below Bonneville Dam; negative median annual population growth rates are expected to continue. Survival improvements needed to meet the survival and recovery indicator criteria range from 3% to 732% (1.03 to 8.32 times the average base period survival rates). For the Lewis and Clark spawning aggregation, improvements of 934% to 1,493% (10.34 to 15.93 times the average base period survival rates) are needed.

Table 9.7-10. Lower Columbia River chinook estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
Aggregations Above Bonneville Dam:										
(insufficient information for analysis)										
Aggregations Below Bonneville Dam:										
Bear Creek	0.73	0.82	1.00	1.00	0.73	0.82	2.14	3.13	1.89	2.83
Big Creek	0.84	0.93	1.00	1.00	0.84	0.93	1.10	1.62	1.31	1.97
Clatskanie	0.80	0.89	1.00	1.00	0.80	0.89	2.93	4.12	1.55	2.32
Cowlitz Tule	0.82	0.92	1.00	1.00	0.82	0.92			1.33	1.99
Elochoman	0.88	0.99	1.00	1.00	0.88	0.99			1.04	1.56
Germany	0.83	0.93	1.00	1.00	0.83	0.93			1.30	1.95
Gnat	0.84	0.94	1.00	1.00	0.84	0.94	2.07	2.95	1.27	1.91
Grays Tule	0.76	0.85	1.00	1.00	0.76	0.85			1.76	2.64
Kalama Spring	0.76	0.85	1.00	1.00	0.76	0.85			1.87	2.80
Kalama	0.89	0.99	1.00	1.00	0.89	0.99			1.06	1.58
Klaskanine	0.80	0.89	1.00	1.00	0.80	0.89	2.30	3.27	1.54	2.30
Lewis R Bright	0.97	0.99	1.00	1.00	0.97	0.99			1.05	1.11
Lewis Spring	0.81	0.91	1.00	1.00	0.81	0.91			1.46	2.20
Lewis, E Fk Tule	0.99	0.99	1.00	1.00	0.99	0.99			1.03	1.03
Lewis and Clark	0.49	0.54	1.00	1.00	0.49	0.54			10.34	15.93
Mill Fall	0.72	0.81	1.00	1.00	0.72	0.81	2.44	3.58	2.19	3.29
Plympton	0.86	0.95	1.00	1.00	0.86	0.95	1.18	1.74	1.21	1.82
Sandy Late	0.98	0.98	1.00	1.00	0.98	0.98	1.00	1.00	1.07	1.09
Skamokawa	0.74	0.82	1.00	1.00	0.74	0.82			2.05	3.08
Youngs	0.84	0.94	1.00	1.00	0.84	0.94	6.73	8.32	1.25	1.88

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] No quantifiable change in survival is expected.
[4] No quantifiable change in survival is expected.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

9.7.2.5.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the likelihood that the RPA would meet the survival and recovery indicator criteria. However, these comments were not specific to, or relevant to, LCR chinook salmon. In fact, this analysis contains assumptions that may make the results overly pessimistic. For example, NMFS assumes that all supplementation programs cease immediately, and that the background survival rate will continue as it has since 1980. These points are addressed in Section 6.3.1.5.

9.7.2.5.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include qualitative assessments of the effects of the RPA on survival below Bonneville Dam or changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-10 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for LCR chinook salmon. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival and estuary survival. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA provides mechanisms for pursuing additional, more intensive actions within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.6 Snake River Steelhead

Evaluation of species-level effects of the RPA requires placing the action-area effects in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of SR steelhead in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. Hydrosystem projects create substantial habitat blockages for this ESU. The major ones are the Hells Canyon Complex on the mainstem Snake River and Dworshak Dam on the North Fork of the Clearwater River. Minor blockages are common throughout the region. Steelhead spawning areas have been degraded by overgrazing, as well as by historical gold dredging and sedimentation due to poor land management. Hatchery fish are widespread and stray to spawn naturally throughout the region. In the 1990s, an average of 86% of adult steelhead passing Lower Granite Dam were of hatchery origin. However, hatchery contribution to naturally spawning populations varies across the region. Some stocks are dominated by hatchery fish, whereas others are composed of all wild fish.

In this section, NMFS quantitatively evaluates the action-area effects associated with the hydrosystem component of the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions are sufficient to change annual population growth rates such that survival and recovery are likely.

9.7.2.6.1 Populations Evaluated

NMFS evaluated A-run and B-run aggregate groups of SR steelhead (McClure et al. 2000b,c). These analyses are based on Lower Granite Dam counts, with the two groups distinguished by date and/or size. Once past Lower Granite Dam, SR steelhead spawn in tributaries throughout the lower Snake River basin, and it is likely that there are multiple populations within these aggregates. However, populations have not yet been defined according to criteria in McElhany et al. (2000) and spawner data from tributaries are not available. The Idaho Department of Fish and Game, in comments on the July 27, 2000, Draft Biological Opinion, suggested that NMFS should assign lower abundance levels to each aggregate group, to simulate the greater risk of extinction faced by smaller populations that probably exist in the basin. In response, NMFS evaluated the sensitivity of necessary survival changes to steelhead pseudopopulations, defined as 10% of the abundance of the A-run aggregate and 33% of the B-run aggregate abundance (McClure et al. 2000b; Appendix A). These approximations were based on information on spawning distribution contained in Busby et al. (1996) and the 1990 NWPPC subbasin plans (Tucannon River, Salmon River, Grande Ronde River, and Clearwater River plans). Those documents identify the major summer steelhead spawning areas with respect to each ESU. B-run steelhead are believed to return mainly to three general areas (Middle Fork Salmon River, Upper Salmon River, and South Fork Salmon River). Summer steelhead returns classified as A-run appear to be distributed among a wider array of spawning areas throughout the Snake River region.

9.7.2.6.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria. NMFS also estimated the change from base period lambda necessary to achieve $\geq$50% likelihood of meeting the lambda $\geq$1.0 (Appendix A) recovery indicator criterion. Details of these estimates are included in Appendix A.

9.7.2.6.3 Expected Survival Change

The necessary improvements in population growth rate described above are based on the assumption that life-stage survival rates influencing adult returns in the base period will continue indefinitely. However, in Section 6.3.6.3, NMFS estimates that current survival of the A-run aggregate represents a 33%-to-42% improvement over the average survival rate influencing base period adult returns. NMFS estimated that B-run survival has improved 44% to 54%. These estimates represent a combination of reduced harvest rates, which differ for the two aggregates, and an expectation that juvenile passage survival has changed proportionate to that of SR spring/summer chinook salmon for both stocks. Rationale and methods are described in Section 6.3.6.3 and Appendix A.

Implementing the hydrosystem component of the RPA will proportionally increase adult survival beyond the current level by an additional 3.9%, based on information in Table 9.7-5. The hydrosystem component of the RPA will also increase juvenile survival to below Bonneville Dam, including differential post-Bonneville survival of transported fish (D) of 52% to 58%, by 4.4% (Table 9.7-5). The product of the proportional survival improvements associated with the current conditions, including harvest reductions, and the hydrosystem RPA actions results in an expected survival improvement of 44% to 54% (1.44 to 1.54 times the average base period survival rate) for A-run SR steelhead and 56% to 67% (1.56 to 1.67 times the average base period survival rate) for B-run SR steelhead, as described in Appendix A.

No other quantifiable survival rates changed significantly between the average base period condition and the current condition. NMFS was unable to quantitatively estimate possible changes in egg-to-smolt survival, estuary survival, and adult survival above Lower Granite Dam that may have resulted from habitat and hatchery management actions, so no change in these survival rates is included in this quantitative analysis. In Section 9.7.2.6.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.6.4 Additional Necessary Survival Changes

Table 9.7-11 shows the effect of the 44% to 54% A-run survival rate increase and the 56% to 67% B-run survival increase expected from the hydrosystem component of the RPA on the future median annual population growth rates. The survival improvement is not sufficient to reduce the declining population trend for SR steelhead. Additional survival improvement ranging from 44% to 333%, depending on assumptions and aggregate run, would be necessary to achieve the recovery indicator criterion of lambda greater than or equal to 1.0.

The effect of the proposed action on the ability to meet the recovery indicator criterion was not affected by the pseudopopulation sensitivity analysis because the pseudopopulations were assumed to have the same abundance trends as the A-run and B-run aggregates. The use of pseudopopulations did increase the risk of extinction, compared with that of the aggregates, but not significantly. For example, the highest estimate of the survival improvement necessary to meet the survival indicator criteria was 152% for the B-run aggregate and 165% for the B-run pseudopopulation (Table 9.7-11). In all cases, it was more difficult to meet the recovery

Table 9.7-11. Snake River steelhead estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.72	0.83	1.50	1.61	0.78	0.91	0.93	1.94	1.58	3.60
A-Run Aggregate	0.74	0.85	1.44	1.54	0.80	0.93	0.85	1.74	1.44	3.14
A-Run Pseudopopulation[9]	0.74	0.85	1.44	1.54	0.80	0.93	0.96	1.93	1.44	3.14
B-Run Aggregate	0.74	0.84	1.56	1.67	0.80	0.90	1.18	2.52	1.92	4.33
B-Run Pseudopopulation[10]	0.74	0.84	1.56	1.67	0.80	0.90	1.25	2.65	1.92	4.33

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] Low represents SR spring/summer chinook low estimate.
[4] High represents SR spring/summer chinook high estimate.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.
[9] Pseudopopulation is 10% of A-run aggregate abundance
[10] Pseudopopulation is 33% of B-run aggregate abundance

indicator criteria than the survival indicator criteria, so the overall needed survival change was not affected by the use of pseudopopulations.

9.7.2.6.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the RPA's ability to achieve survival and recovery indicator criteria. Substantial comments primarily questioned 1) the estimates of hydrosystem survival associated with the RPA (addressed in Section 6.2), 2) the method of estimating the expected proportional change in the juvenile survival rate from the average associated with base period returns (addressed in Section 6.3.6.3 with one new and one modified method of estimating the expected change for SR spring/summer chinook; the application of that survival change to steelhead was not questioned), 3) the assumption that the effectiveness of hatchery-origin spawners may have been as low as 20% that of wild-origin spawners (addressed in Section 6.3.2.3), and 4) the analytical assumption that all survival changes are achieved instantaneously. This last point is addressed below.

The simple analytical approach used in this biological opinion does assume that all survival changes are instantaneous (McClure et al. 2000c). To the extent that improvements are implemented gradually, the analysis underestimates the survival change that will ultimately be required. The magnitude of the additional change for SR steelhead is unknown. The potential effect of delay on SR steelhead may be inferred from analyses of three chinook salmon ESUs. NMFS evaluated a 10-year delay in implementing the hydrosystem component of the RPA and in achieving any survival improvements in other life stages (Appendix A) for SR spring/summer chinook (Section 9.7.2.1.5), SR fall chinook (Section 9.7.2.2.5), and UCR spring chinook (Section 9.7.2.3.5). These analyses also assumed that there has been no change from average 1980-to-most-recent-year survival as a result of current hydrosystem operations (including those of the PUD projects for UCR spring chinook) and harvest reductions (SR fall chinook), which are already implemented. The results indicated that these pessimistic assumptions would result in a substantially greater necessary survival improvement at the end of 10 years for UCR spring chinook (highest necessary change [178%] increased to 368%). They also indicated that a much smaller effect would occur for SR fall chinook (highest necessary change [44%] increased to 69%). Results for the SR spring/summer chinook index stocks were intermediate. NMFS qualitatively considers possible inferences from these chinook ESUs to SR steelhead in making a jeopardy determination.

This analysis also contains assumptions that may make the results overly pessimistic. Three of these are the analytical assumptions that all spawning aggregates behave as independent populations, that all supplementation programs cease immediately, and that background survival will continue as it has from 1980 to the present. These assumptions are discussed in Section 6.3.6.5.

9.7.2.6.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-11 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for SR steelhead. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival above Lower Granite Dam. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. The RPA also provides mechanisms for pursuing additional, more intensive, actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.7 Upper Columbia River Steelhead

Evaluation of species-level effects of the RPA requires placing the action-area effects in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of UCR spring chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. Specifically, Chief Joseph and Grand Coulee dams block substantial portions of the historical spawning range. Habitat problems are largely related to irrigation diversions and hydroelectric dams, as well as degraded riparian and instream habitat from urbanization and livestock grazing. Hatchery fish are widespread and escape to spawn naturally throughout the region. The relative contribution of these hatchery spawners to natural production rates is unknown.

In this section, NMFS quantitatively evaluates the action-area effects associated with the hydrosystem component of the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions are sufficient to change annual population growth rates such that survival and recovery are likely.

9.7.2.7.1 Populations Evaluated

Ford et al. (1999) identified at least three populations comprising this ESU: the Wenatchee River population, the Methow River population, and the Entiat River population. Ford et al. (1999) identified interim recovery goals for each population and included the criterion that all three must meet these goals for delisting. Steelhead spawner estimates are available only from dam counts, so Cooney (2000) evaluated the Methow River population based on Wells Dam counts and evaluated the combined Wenatchee River and Entiat River populations based on differences between Rock Island and Wells Dam counts. McClure et al. (2000b,c) analyzed the aggregate ESU based on Rock Island Dam counts.

9.7.2.7.2 Necessary Survival Change

McClure et al. (2000b,c) and Cooney (2000) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria. Cooney (2000) also estimated the change from base period lambda necessary to achieve $\geq$50%

likelihood of meeting the Methow and combined Wenatchee/Entiat population interim recovery abundance levels (Ford et al. 1999) in 48 and 100 years. NMFS (Appendix A) estimated the survival change necessary to meet the alternative recovery indicator criterion of lambda $\geq$ 1.0 for the aggregate run, using lambda estimates from McClure et al. (2000b) and methods described in Appendix A. The CRI analytical approach (McClure et al. 2000c) and the QAR analytical approach (Cooney 2000) produce different estimates of necessary survival changes for these populations. NMFS considers both approaches to have advantages and disadvantages and uses results from both to define a range of necessary survival change.

9.7.2.7.3 Expected Survival Change

The necessary improvements in population growth rate described above are based on the assumption that life-stage survival rates influencing adult returns from base period will continue indefinitely. However, the Basinwide Recovery Strategy identifies implementation of the Mid-Columbia HCP at five PUD projects as a probable element of recovery planning that is, therefore, included in the analysis, consistent with step 4 of the jeopardy analysis framework described in Section 1.3. The Basinwide Recovery Strategy estimates that this action will be implemented within 2 to 5 years. Cooney (2000, Table 20) estimates that implementation of the HCP will improve survival 23% for the Wenatchee population, 33% for the Entiat population, and 38% for the Methow population.

In addition, in Section 6.3.7.3, NMFS estimates that current FCRPS hydrosystem survival, combined with implementation of the Mid-Columbia HCP and harvest reductions, represents a 12%-to-43% improvement over the average survival rate influencing base period adult returns. The range represents different effects of the HCP on each population and a range of estimates of the historical differential post-Bonneville survival (D = 0.8 to D = 1.0) in years when fish were transported from McNary Dam. Implementing the hydrosystem component of the RPA will proportionally increase adult survival through the FCRPS projects beyond the current level by an additional 1.6%, based on information in Table 9.7-5. The hydrosystem component of the RPA is also expected to proportionally increase juvenile survival to below Bonneville Dam by 15.2% (Table 9.7-5; Appendix A). The product of the proportional survival improvements associated with the current conditions, implementation of the HCP, and implementation of the hydrosystem RPA results in an expected survival improvement of 31% to 68% (1.31 to 1.68 times the average base period survival rate), as described in Appendix A.

No other quantifiable survival rates changed significantly between the average base period and the current condition. NMFS was unable to quantitatively estimate possible changes in egg-to-smolt survival (other than those associated with the HCP; Cooney 2000), estuary survival, and adult survival above the upper dam that may have resulted from habitat and hatchery management actions, so no change in these survival rates is included in this quantitative analysis. In Section 9.7.2.7.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.7.4 Additional Necessary Survival Changes

Table 9.7-12 shows the effect of the 31%-to-68% survival rate increase expected from the hydrosystem component of the RPA on the future median annual population growth rates for the Methow and Wenatchee/Entiat populations and the aggregate ESU. Because different methods were used to estimate the population requirements and the aggregate ESU requirements, differences may be a result of either the analytical method or the scale of the analysis. Low estimates of the population growth rate indicate that it will continue to be negative after HCP implementation and continuation of the proposed action. High estimates indicate, however, that the Methow River and Wenatchee/Entiat River population growth rate will be positive. No additional survival improvements are necessary for Methow and Wenatchee/Entiat populations under the most optimistic estimates. For all other cases, however, additional survival improvements ranging from 26% to 193% (1.26 to 2.93 times the average base period survival rate) will be necessary to meet the recovery indicator criteria.

Table 9.7-12. Upper Columbia River steelhead estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

							Additional Change In Survival Needed to Achieve:			
	1980-Current Lambda		Expected Survival Change		Expected Lambda		5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
Spawning Aggregation	**Low[1]**	**High[2]**	**Low[3]**	**High[4]**	**Low[5]**	**High[6]**	**Low[7]**	**High[8]**	**Low[7]**	**High[8]**
UCR Steelhead Aggregate - CRI	0.69	0.83	1.39	1.59	0.75	0.94	1.02	2.36	1.26	2.93
Methow - QAR	0.81	0.97	1.48	1.68	0.90	1.11	0.69	1.46	0.92	2.10
Wenatchee/Entiat - QAR[9]	0.85	0.94	1.31	1.49	0.91	1.04	0.75	1.27	1.00	1.67

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] Low represents an estimate of juvenile survival improvement based on assumption of historical D=0.8 from McNary Dam .
[4] High represents an estimate of juvenile survival improvement based on assumption of historical D=1.0 from McNary Dam.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.
[9] Expected survival change is based on the Wenatchee estimate of HCP survival increase (Cooney 2000 Table 20). Entiat estimate from same source is higher.

9.7.2.7.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the proposed action's ability to achieve survival and recovery indicator criteria. Most comments were not specific to, or in some cases relevant to, UCR steelhead. However, three comments of particular relevance were that NMFS should not assume that the Mid-Columbia HCP will be implemented and achieve its survival goals within the time described in the Basinwide Recovery Strategy; that the analysis is overly optimistic because it assumes that all survival changes are achieved instantaneously; and that the analysis is overly optimistic because NMFS rejected the assumption of 80% effectiveness of hatchery-origin natural spawners. As described in Section 6.3.6.5, NMFS considers the full range of hatchery spawner effectiveness in this biological opinion.

The first comment applies to implementation of the proposed Mid-Columbia HCP. CRITFC believes that anticipated HCP survival rates will not be achieved at all five PUD dams for at least 10 years because long-term gas-abatement projects are needed to achieve the necessary spill levels. NMFS agrees that there is some uncertainty about the exact schedule for achieving all survival improvements anticipated in the HCP, but the proposed HCP for the Chelan and Douglas PUDs and the draft EIS anticipate that the survival improvements will be achieved by the end of Phase I (2003). If this does not occur, it is reasonable to anticipate additional changes under the terms of the proposed HCP.

Regardless of the exact implementation schedule, the analysis described above does assume that HCP and hydrosystem RPA survival improvements are achieved immediately. NMFS conducted a sensitivity analysis on the effect of a 10-year delay in implementing *any* survival improvements over the base period average survival rate for UCR spring chinook (Section 6.3.3.5; Appendix C). Under this worst-case scenario, the CRI estimate of necessary survival change for the Wenatchee population increased significantly from the estimate that assumed immediate implementation. This extreme scenario is unlikely, since some improvements associated with the HCP have already been achieved, but NMFS considers the implications of delayed implementation qualitatively in reaching jeopardy conclusions for this ESU.

This analysis contains assumptions that may make the results overly pessimistic. Two such assumptions are that all supplementation programs cease immediately and that background survival will continue as it has since 1980. These assumptions are discussed in Section 6.3.7.5.

9.7.2.7.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include changes in survival in other life stages that result from habitat or hatchery management, other than effects anticipated in the HCP. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-12 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for Upper Columbia River steelhead. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival above the upper-most dam for each population. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA provides mechanisms for pursuing additional, more intensive, actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.8 Middle Columbia River Steelhead

Evaluation of species-level effects of the RPA requires placing the action-area effects in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of SR spring/summer chinook salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include timber harvest (altered riparian vegetation, unstable streambanks, and decreased habitat complexity), agricultural practices (channelization and loss of riparian vegetation), road construction, and urban and industrial development. Pelton Dam on the Deschutes River blocks access to historical spawning areas, and there are numerous minor blockages from smaller dams and impassable culverts throughout the region. In addition, the genetic integrity of the ESU is threatened by past and present hatchery practices. Hatchery fish are widespread and escape to spawn naturally throughout the region, so that adults of hatchery origin make up a substantial portion of the spawning population in several basins (e.g., the Umatilla and Deschutes rivers).

In this section, NMFS evaluates the action-area effects associated with the hydrosystem component of the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions are sufficient to change annual population growth rates such that survival and recovery are likely.

9.7.2.8.1 Populations Evaluated

NMFS evaluated four spawning aggregations of MCR steelhead. The Yakima River aggregation passes through four FCRPS projects, the Umatilla River aggregation passes through three

FCRPS projects, and the Deschutes River and Warm Springs aggregations pass through two FCRPS projects. NMFS has not yet determined which, if any, of these spawning aggregations represent populations, as defined by McElhany et al. (2000), but treating the four aggregations as independent populations satisfies the statistical assumptions inherent in the analysis.

9.7.2.8.2 Necessary Survival Change

McClure et al. (2000b) described changes from the 1980-to-1994 (Yakima and Warm Springs) or 1980-to-1986 (Deschutes and Umatilla) median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria. NMFS also estimated the change from the 1980-to-1994/1996 lambda necessary to meet the recovery indicator criterion of lambda $\geq$1.0. Details of these estimates are found in Appendix A.

9.7.2.8.3 Expected Survival Change

The necessary improvements in population growth rate described above are based on the assumption that life-stage survival rates influencing adult returns in the base period will continue indefinitely. However, in Section 6.3.8.3, NMFS estimates that current survival of the Yakima River spawning aggregation represents a -9% to +4% improvement from the average survival rate influencing 1980-to-1994 adult returns. NMFS estimated a 14% increase for the Umatilla spawning aggregation and a 7% increase for the Deschutes and Warm Springs spawning aggregations. These estimates represent a combination of reduced harvest rates, which NMFS assumes equal to the SR A-run steelhead harvest reductions, and increased juvenile passage survival. Rationale and methods are described in Section 6.3.8.3 and Appendix A.

Implementing the hydrosystem component of the RPA will proportionally increase adult survival beyond the current level by an additional 1.7% to 3.%%, depending on the number of FCRPS dams each spawning aggregate passes (Table 9.7-5). The hydrosystem component of the RPA will also increase juvenile survival to below Bonneville Dam by 11.7% to 15.2%, depending on the number of dams passed (Table 9.7-5). The product of the proportional survival improvements associated with the current conditions, including harvest reductions, and the hydrosystem RPA actions results in an expected survival improvement of 9% to 24% (1.09 to 1.24 times the average 1980-to-1994 survival rate) for the Yakima stock; 33% (1.33 times the average 1980-to-1996 survival rate) for the Umatilla stock; and 22% (1.22 times the average base period survival rate) for the Deschutes and Warm Springs stocks, as described in Appendix A.

No other quantifiable survival rates changed significantly between the average base period and the current condition. NMFS was unable to quantitatively estimate possible changes in egg-to-smolt survival, estuary survival, and adult survival above the upper dam that may have resulted from habitat and hatchery management actions, so no change in these survival rates is included in this quantitative analysis. In Section 9.7.2.8.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.8.4 Additional Necessary Survival Changes

Table 9.7-13 shows the effect of the 9% to 33% survival rate change expected from the hydrosystem component of the RPA on the future median annual population growth rates for the four MCR steelhead spawning aggregations in this analysis. Population growth rates are expected to be negative for all aggregations except the Yakima River aggregation (lambda is 1.03 to 1.08). Additional survival changes of 31% to 226% (1.31 to 3.26 times the base period average survival rates) are necessary to meet recovery indicator criteria for the Deschutes, Warm Springs, and Umatilla spawning aggregations. No additional improvement is needed for the Yakima River aggregation to meet the survival and recovery indicator criteria.

Table 9.7-13. Mid-Columbia River steelhead estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.77	0.84	1.21	1.25	0.80	0.88	N/A	N/A	1.92	3.18
Deschutes R Sum	0.77	0.84	1.22	1.22	0.80	0.87	1.28	2.06	2.02	3.26
Warm Springs NFH Sum	0.91	0.91	1.22	1.22	0.94	0.94	1.16	1.19	1.36	1.36
Umatilla R Sum	0.90	0.90	1.33	1.33	0.95	0.95	0.88	0.86	1.31	1.27
Yakima R Sum	1.01	1.04	1.09	1.24	1.03	1.08	0.81	0.92	0.67	0.85

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] Low for Yakima R. represents an estimate of juvenile survival improvement based on assumption of historical D=0.8 from McNary Dam.
[4] High for Yakima R. represents an estimate of juvenile survival improvement based on assumption of historical D=1.0 from McNary Dam.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

9.7.2.8.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the proposed action's ability to achieve survival and recovery indicator criteria. Most comments were not specific to, or in some cases relevant to, MCR steelhead. However, two comments of particular relevance were that the analysis is overly optimistic because it assumes that all survival changes are achieved instantaneously, and that the analysis is overly optimistic because NMFS rejected the assumption of 80% effectiveness of hatchery-origin natural spawners. As described in Section 6.3.8.5, NMFS considers the full range of hatchery spawner effectiveness in this biological opinion.

The simple analytical approach used in this biological opinion assumes that all survival changes are instantaneous (McClure et al. 2000c). To the extent that improvements are implemented gradually, the analysis underestimates the survival change that will ultimately be required. The magnitude of the additional change for MCR steelhead is unknown. The potential effect of delay on MCR steelhead may be inferred from analyses of three chinook salmon ESUs. NMFS evaluated a 10-year delay in implementing the hydrosystem component of the RPA and in achieving any survival improvements in other life stages (Appendix A) for SR spring/summer chinook (Section 9.7.2.1.5), SR fall chinook (Section 9.7.2.2.5), and UCR spring chinook (Section 9.7.2.3.5). The analyses also assumed that there has been no change from average-1980 to most-recent-year survival as a result of current hydrosystem operations (including those of the PUD projects for UCR spring chinook) and harvest reductions (SR fall chinook), which are already implemented. The results indicated that these pessimistic assumptions would result in a substantially greater necessary survival improvement at the end of 10 years for UCR spring chinook (highest necessary change [178%] increases to 368%). They also indicated that a much smaller effect would occur for SR fall chinook (highest necessary change [44%] increased to 69%). Results for the SR spring/summer chinook index stocks were intermediate. NMFS qualitatively considers possible inferences from these chinook ESUs to MCR steelhead in making a jeopardy determination.

This analysis also contains assumptions that may make the results overly pessimistic. Three of these are the analytical assumptions that all spawning aggregates behave as independent populations; that all supplementation programs cease immediately; and that background survival will continue as it has from 1980 to the present. These assumptions are discussed in Section 6.3.8.5.

9.7.2.8.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-13 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for MCR steelhead. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival above the upper dam passed by each stock. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with those expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA provides mechanisms for pursuing additional, more intensive, actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.9 Upper Willamette River Steelhead

Evaluation of the species-level effects of the RPA requires placing the action-area effects of the RPA in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of UWR steelhead in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include the loss of habitat due to inundation or blockages resulting from the construction of numerous tributary hydroelectric and irrigation facilities; and habitat degradation due to timber harvest, development (agricultural, municipal, and industrial), dam development, and river channelization and dredging. Many of these activities result in poor water quality, high sediment loads, altered thermal regimes, and a large reduction in available spawning and rearing habitat. Overharvest and hatchery production have also contributed to the decline of this ESU.

In this section, NMFS quantitatively evaluates the action-area effects associated with the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions could increase annual population growth rates such that survival and recovery are likely.

9.7.2.9.1 Populations Evaluated

NMFS quantitatively evaluated four spawning aggregations: the Molalla, North Santiam, South Santiam, and Calapooia river populations. NMFS has not yet determined which, if any, of the UWR steelhead spawning aggregations represent populations, as defined by McElhany et al. (2000), but treating the four aggregations as independent populations satisfies the statistical assumptions inherent in the analysis.

9.7.2.9.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria for the four spawning aggregations. NMFS also estimated the change from base period lambda necessary to achieve

≥50% likelihood of meeting the recovery indicator criterion of lambda ≥1.0 for each aggregation. Details of these estimates are provided in Appendix A.

9.7.2.9.3 Expected Survival Change

NMFS' calculation of the necessary survival change (improvement in population growth rate) for UWR steelhead, referenced above, assumes that the life-stage survival rates that influenced the base period adult returns will continue indefinitely. NMFS cannot identify any significant changes in survival rates under the RPA compared to those that influenced the base period adult returns because survival changes due to implementing the RPA can be quantified only for species that migrate past mainstem dams (which excludes UWR steelhead). NMFS was also unable to quantify potential changes in egg-to-smolt survival, estuary survival, or adult survival that may have resulted from recent or ongoing habitat and hatchery management actions. Instead, in Section 9.7.2.9.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.9.4 Additional Necessary Survival Changes

Table 9.7-14 shows that the RPA is not expected to increase the population survival rate; negative median annual population growth rates are expected to continue for each of the four UWR steelhead spawning aggregations. Survival improvements needed to meet the recovery indicator criteria range from 30% to 108% (1.30 to 2.08 times the average base period survival rates).

9.7.2.9.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the likelihood that the RPA would meet the survival and recovery indicator criteria. However, these comments were not specific to, or relevant to, UWR steelhead. In fact, this analysis contains assumptions that may make the results overly pessimistic. For example, NMFS assumes that all supplementation programs cease immediately and that the background survival rate will continue as it has since 1980. These points are addressed in Section 6.3.1.5.

9.7.2.9.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include qualitative assessments of the effects of the RPA on survival below Bonneville Dam, or changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-14 are likely to be achieved through recent or anticipated future actions that affect other life stages.

Table 9.7-14. Upper Willamette River steelhead estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

							Additional Change In Survival Needed to Achieve:			
	1980-Current Lambda		Expected Survival Change		Expected Lambda		5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
Spawning Aggregation	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.88	0.92	1.00	1.00	0.88	0.92	1.13	1.39	1.37	1.69
Molalla	0.84	0.91	1.00	1.00	0.84	0.91	1.34	1.96	1.45	2.08
N Santiam R	0.89	0.92	1.00	1.00	0.89	0.92	1.20	1.34	1.42	1.58
S Santiam	0.87	0.94	1.00	1.00	0.87	0.94	1.06	1.50	1.30	1.78
Calapooia	0.93	0.93	1.00	1.00	0.93	0.93	1.53	1.53	1.36	1.36

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] No quantifiable change in survival is expected.
[4] No quantifiable change in survival is expected.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for UWR steelhead. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival, estuary survival, and prespawning adult survival (above Willamette Falls). Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.10 Lower Columbia River Steelhead

Evaluation of the species-level effects of the RPA requires placing the action-area effects of the RPA in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of LCR steelhead in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include timber harvest (altered riparian vegetation, unstable streambanks, and decreased habitat complexity), agricultural practices (channelization and loss of riparian vegetation), road construction, and urban and industrial development. Upstream passage is blocked by dams on the Lewis, Clackamas, Sandy, and Hood rivers, and there are minor blockages (such as impassable culverts) throughout the region. Mudflows from the eruption of Mt. St. Helens (1980) significantly disrupted and degraded habitat in the South Fork Toutle and Green rivers, as did post-eruption dredging, diking, and bank protection works in the Cowlitz River below its confluence with the Toutle River. In addition, the genetic integrity of the ESU is threatened by past and present hatchery practices. Each year, hatcheries release approximately 3 million steelhead smolts in basins occupied by the ESU (Busby et al. 1996). In many basins, hatchery strays compose most of the spawning population.

In this section, NMFS quantitatively evaluates the action-area effects associated with the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions could increase annual population growth rates such that survival and recovery are likely.

9.7.2.10.1 Populations Evaluated

NMFS quantitatively evaluated seven spawning aggregations below Bonneville Dam. Adequate information was not available for similar analyses for spawning aggregations above Bonneville Dam. NMFS has not yet determined which, if any, of the LCR steelhead spawning aggregations represent populations, as defined by McElhany et al. (2000), but treating the seven aggregations as independent populations satisfies the statistical assumptions inherent in the analysis.

9.7.2.10.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rates (lambda) that are necessary to meet the survival indicator criteria for the seven subbasin spawning aggregations. NMFS also estimated the change from the base period lambda necessary to achieve ≥50% likelihood of meeting the recovery indicator criterion of lambda ≥1.0 for each aggregation. Details of these estimates are provided in Appendix A.

9.7.2.10.3 Expected Survival Change

NMFS' calculation of the necessary survival change (improvement in population growth rate) for the seven spawning aggregations of LCR steelhead, referenced above, assumes that the life-stage survival rates that influenced the base period adult returns for winter steelhead in the Clackamas, Green, Kalama, Sandy, and Toutle rivers will continue indefinitely. Adult harvest rates for summer steelhead in the Clackamas and Kalama subbasins have changed, however. NMFS assumes that the size of the change from the average rate over the base period is similar to that estimated for other summer-run steelhead in the Columbia basin. The A-run harvest rate reduction resulted in a survival increase of 7.2% for SR steelhead (Section 6.3.6.3).

Although structural and operational modifications have been made to Bonneville Dam since 1980, none of the spawning aggregations for which NMFS could perform quantitative analyses pass this project. NMFS was also unable to quantify potential changes in egg-to-smolt or estuary survival that may have resulted from recent or ongoing habitat and hatchery management actions. Instead, in Section 9.7.2.10.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.10.4 Additional Necessary Survival Changes

Table 9.7-15 shows that the RPA is expected to increase the survival rate of two of the LCR steelhead spawning aggregations because of harvest rate reductions. Negative median annual population growth rates are expected to continue for all seven aggregations, however. Survival improvements needed to meet the survival and recovery indicator criteria range from 13% to 376% (1.13 to 4.76 times the average base period survival rates).

Table 9.7-15. Lower Columbia River steelhead estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

							Additional Change In Survival Needed to Achieve:			
	1980-Current Lambda		Expected Survival Change		Expected Lambda		5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
Spawning Aggregation	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.80	0.91	1.00	1.00	0.80	0.91	N/A	N/A	1.53	2.71
Aggregations Above Bonneville Dam:										
(insufficient information for analysis)										
Aggregations Below Bonneville Dam:										
Clackamas Sum	0.73	0.83	1.07	1.07	0.74	0.84	1.75	3.34	2.44	4.76
Clackamas Win	0.76	0.88	1.00	1.00	0.76	0.88	1.35	2.57	1.75	3.43
Green River Win	0.90	0.90	1.00	1.00	0.90	0.90	1.80	1.80	1.58	1.58
Kalama Sum	0.77	0.91	1.07	1.07	0.78	0.92	1.09	2.50	1.51	3.67
Kalama River Win	0.90	0.97	1.00	1.00	0.90	0.97	1.00	1.14	1.13	1.58
Sandy Win	0.85	0.91	1.00	1.00	0.85	0.91	1.19	1.63	1.49	2.08
Toutle Win	0.88	0.88	1.00	1.00	0.88	0.88	1.30	1.30	1.81	1.81

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] No quantifiable change in survival is expected.
[4] No quantifiable change in survival is expected.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

9.7.2.10.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations commented that the analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the likelihood that the RPA would meet the survival and recovery indicator criteria. However, these comments were not specific to, or relevant to, LCR steelhead. In fact, this analysis contains assumptions that may make the results overly pessimistic. For example, NMFS assumes that all supplementation programs cease immediately, and that the background survival rate will continue as it has since 1980. These points are addressed in Section 6.3.1.5.

9.7.2.10.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include qualitative assessments of the effects of the RPA on survival below Bonneville Dam or changes in survival in other life stages that result from habitat or hatchery management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-15 are likely to be achieved through recent or anticipated future actions that affect other life stages.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for LCR steelhead. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival and estuary survival. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.11 Columbia River Chum Salmon

Evaluation of the species-level effects of the RPA requires placing the action-area effects of the RPA in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of CR chum salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include water withdrawals, conveyance, storage, and flood control, resulting in insufficient flows, stranding, juvenile entrainment, and instream temperature increases; logging and agriculture (loss of large woody debris, sedimentation, loss of riparian vegetation, and habitat simplification); mining (especially gravel removal, dredging, and pollution); urbanization (stream channelization, increased runoff, pollution, and habitat simplification); development of many small hydropower facilities in lower river areas; passage mortality at Bonneville Dam; and substantial habitat loss in the Columbia River estuary and associated areas.

In this section, NMFS quantitatively evaluates the action-area effects associated with the RPA and the effects of human activities affecting survival in other parts of the life cycle. NMFS determines whether the survival rates expected from the RPA and other likely actions could increase annual population growth rates such that survival and recovery are likely.

9.7.2.11.1 Populations Evaluated

NMFS quantitatively evaluated six spawning aggregations below Bonneville Dam. NMFS has not yet determined which, if any, of the CR chum salmon spawning aggregations represent populations, as defined by McElhany et al. (2000), but treating the six aggregations as independent populations satisfies the statistical assumptions inherent in the analysis.

9.7.2.11.2 Necessary Survival Change

McClure et al. (2000b) described changes from the base period median annual population growth rate (lambda) that are necessary to meet the survival indicator criteria for the six spawning aggregations. NMFS also estimated the change from base period lambda necessary to achieve ≥50% likelihood of meeting the recovery indicator criterion of lambda ≥1.0 for each aggregation. Details of these estimates are provided in Appendix A.

9.7.2.11.3 Expected Survival Change

NMFS' calculation of the necessary survival change (improvement in population growth rate) for CR chum salmon, referenced above, assumes that the life-stage survival rates that influenced the base period adult returns will continue indefinitely. Although structural and operational modifications have been made to Bonneville Dam since 1980, none of the spawning aggregations for which NMFS could perform quantitative analyses passes this project. NMFS was also unable to quantify potential changes in egg-to-smolt or estuary survival that may have resulted from recent or ongoing habitat management actions. Instead, in Section 9.7.2.11.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

9.7.2.11.4 Additional Necessary Survival Changes

Table 9.7-16 shows that the RPA is not expected to increase spawning aggregation survival rates. Negative median annual population growth rates are expected to continue for two of the CR chum salmon spawning aggregations (mainstem Grays River and Hamilton Creek). An additional survival improvement of from 18% to 36% (1.18 to 1.36 times the average base period survival rates) is needed to meet the recovery indicator criteria for these two spawning aggregations.

Table 9.7-16. Columbia River chum salmon estimates of current and expected median annual population growth rate (lambda), expected survival change from RPA, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA.

Spawning Aggregation	1980-Current Lambda Low[1]	1980-Current Lambda High[2]	Expected Survival Change Low[3]	Expected Survival Change High[4]	Expected Lambda Low[5]	Expected Lambda High[6]	Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years Low[7]	5% Extinction Risk In 100 Years High[8]	50% Recovery In 48 Years or Lambda = 1.0 Low[7]	50% Recovery In 48 Years or Lambda = 1.0 High[8]
ESU Aggregate	1.04	1.04	1.00	1.00	1.04	1.04	N/A	N/A	0.88	0.88
Aggregations Above Bonneville Dam:										
(insufficient information for analysis)										
Aggregations Below Bonneville Dam:										
Grays R west fork	1.23	1.23	1.00	1.00	1.23	1.23	N/A	N/A	0.47	0.47
Grays R mouth to head	0.96	0.96	1.00	1.00	0.96	0.96	N/A	N/A	1.18	1.18
Hardy Creek	1.05	1.05	1.00	1.00	1.05	1.05	N/A	N/A	0.85	0.85
Crazy Johnson	1.16	1.16	1.00	1.00	1.16	1.16	N/A	N/A	0.59	0.59
Hamilton	0.92	0.92	1.00	1.00	0.92	0.92	N/A	N/A	1.36	1.36
Hamilton Springs	1.11	1.11	1.00	1.00	1.11	1.11	N/A	N/A	0.68	0.68

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] No quantifiable change in survival is expected.
[4] No quantifiable change in survival is expected.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

9.7.2.11.5 Other Factors Influencing Quantitative Analytical Results

Several agencies and organizations comments that NMFS' analysis in the July 27, 2000, Draft Biological Opinion, which is very similar to this analysis, produced an overly optimistic estimate of the likelihood that the RPA would meet the survival and recovery indicator criteria. However, these comments were not specific to, or relevant to, CR chum salmon. In fact, this analysis contains an assumption that may make the results overly pessimistic. For example, NMFS assumes that the background survival rate will continue as it has since 1980. This point was addressed in Section 6.3.1.5.

9.7.2.11.6 Qualitative Assessment of Egg-to-Smolt Survival, Estuarine Survival, and Prespawning Adult Survival Changes Caused by Human Activities

The quantitative analysis described above does not include qualitative assessments of the effects of the RPA on survival below Bonneville Dam or changes in survival in other life stages that result from habitat management. In this section, NMFS qualitatively evaluates the question whether the additional necessary survival improvements described in Table 9.7-16 are likely to be achieved through recent or anticipated future actions that affect other life stages. NMFS was also unable to quantify potential changes in egg-to-smolt or estuary survival that may have resulted from recent or ongoing habitat management actions. Instead, in Section 9.7.2.11.6, NMFS makes a qualitative judgment about whether further changes in survival can be expected from the habitat and hatchery actions described in the Basinwide Recovery Strategy and the RPA.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in Section 1.3 of the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for CR chum salmon. The improvements will probably be expressed as changes from the average base period, egg-to-smolt survival and estuary survival. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA provides mechanisms for pursuing additional, more intensive actions within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.12 Snake River Sockeye Salmon

Evaluation of the species-level effects of the RPA requires placing the action-area effects of the RPA in the context of the full life cycle. The factors described in Section 9.7.1 affect elements of critical habitat and the survival and recovery of SR sockeye salmon in the action area. A large number of additional factors (summarized in Myers et al. 1998, Section 4.1, and Appendix C) limits this ESU over its full range. These include tributary hydropower and irrigation storage projects that block or restrict fish passage, water withdrawals that dewater streams, and unscreened diversions.

Because the abundance of SR sockeye salmon is extremely low, the risk of extinction cannot be calculated using the methods that NMFS employs in this biological opinion. However, the risk is undoubtedly very high. Other factors that affect elements of critical habitat also contribute to this ESU's high risk of extinction (summarized in Section 4.1 and Appendix C), but the FCRPS is a significant factor. The high risk of extinction is partially mitigated by a captive breeding program, funded by the Action Agencies, which provides some assurance that SR sockeye salmon will not go extinct in the immediate future. However, long-term survival and recovery in the wild require substantial increases in survival throughout the life cycle.

After reviewing numerous biological opinions recently issued for hatchery and habitat actions and the general discussion of these actions in the Basinwide Recovery Strategy, NMFS concludes that the habitat and hatchery actions described in the relevant sections of Volume 2 of the Basinwide Recovery Strategy provide enough potential for offsite mitigation to achieve the additional survival improvements for SR sockeye salmon. The RPA includes a better-defined commitment by the Action Agencies to fund offsite mitigation activities than did the biological assessment. The RPA also calls for performance standards, a schedule, and a process for ensuring that the offsite mitigation activities of the Action Agencies combined with the activities expected of other Federal and non-Federal entities will achieve necessary survival improvements. Further, the RPA calls for mechanisms for pursuing additional, more intensive actions, including possible dam breaching, within the framework for implementation and progress review. Although it is not possible at this time to quantitatively evaluate the effects of these actions on survival in other life stages, these factors, taken together, indicate that the necessary survival improvements are likely to occur.

9.7.2.13 Summary—Effects of RPA on Biological Requirements Over Full Life Cycle

The ESU-specific analyses in Sections 9.7.2.1 through 9.7.2.12 include both quantitative and qualitative assessments.[1] The quantitative analyses show that recent survival changes continued into the future, plus additional survival changes expected to result from implementation of the RPA, will increase the likelihood of meeting the survival and recovery indicator criteria for stocks that pass through one or more FCRPS projects. Summer steelhead stocks throughout the basin, including two of the spawning aggregations in the LCR steelhead ESU, will also benefit from the recent harvest reduction for A-run steelhead in the Snake River basin. However, for all ESUs, many stocks will need additional survival improvements beyond those expected from the RPA. For most ESUs, the additional improvements range from a few percentage points to two orders of magnitude (Table 9.7-17).[2] For LCR chinook salmon spawning in the Lewis and Clark River, a survival improvement of over 1,000 times is needed.

NMFS' qualitative assessment considers the extent to which the RPA affects the capacity of critical habitat to provide biological requirements for listed fish. As described in Sections 4, 5, and 6, a number of factors affect current population trends of Columbia River basin salmonids. The hydro actions in the RPA address mortality in the action area. Actions in habitat, harvest, and hatcheries address human-caused factors that limit survival and recovery elsewhere in the life cycle. For example, habitat actions include protecting productive habitat, restoring tributary flows, screening and combining water diversions, reducing passage obstructions, and improving or restoring degraded habitat (Table 9.7-18). The Federal agencies will focus these near-term actions on priority subbasins for each ESU. Hatchery reforms expected to reduce adverse interactions with wild fish include developing new, local broodstocks (and eliminating inappropriate broodstocks) and managing the number of hatchery fish allowed to spawn

[1]Quantitative assessments are not possible for SR sockeye salmon.

[2] Critical assumptions that influence results for each ESU are discussed in the preceding sections.

Table 9.7-17. Estimated percentage change in additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA. Low and High estimates are based on a range of assumptions, as described in the text. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the proposed action, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

	Needed Survival Change			
Spawning Aggregation	**Low**	**High**		
Snake River Spring/Summer Chinook				
Aggregate ESU	46	89		
Index Stocks				
Bear Valley/Elk Creeks	0	0		
Imnaha River	26	66		
Johnson Creek	0	0		
Marsh Creek	0	12		
Minam River	0	28		
Poverty Flats	0	0		
Sulphur Creek	0	5		
Additional Spawning Aggregations				
Alturas Lake Ck	168	186	*	Based only on Lambda ≥ 1.0
American R	11	19	*	Based only on Lambda ≥ 1.0
Big Sheep Ck	29	58	*	Based only on Lambda ≥ 1.0
Beaver Cr	0	0	*	Based only on Lambda ≥ 1.0
Bushy Fork	0	0	*	Based only on Lambda ≥ 1.0
Camas Cr	4	11	*	Based only on Lambda ≥ 1.0
Cape Horn Cr	0	0	*	Based only on Lambda ≥ 1.0
Catherine Ck	50	131	*	Based only on Lambda ≥ 1.0
Catherine Ck N Fk	4	12	*	Based only on Lambda ≥ 1.0
Catherine Ck S Fk	101	114	*	Based only on Lambda ≥ 1.0
Crooked Fork	0	0	*	Based only on Lambda ≥ 1.0
Grande Ronde R	58	142	*	Based only on Lambda ≥ 1.0
Knapp Cr	22	30	*	Based only on Lambda ≥ 1.0
Lake Cr	0	0	*	Based only on Lambda ≥ 1.0
Lemhi R	0	0	*	Based only on Lambda ≥ 1.0
Lookingglass Ck	102	225	*	Based only on Lambda ≥ 1.1
Loon Ck	0	0	*	Based only on Lambda ≥ 1.0
Lostine Ck	15	44	*	Based only on Lambda ≥ 1.0
Lower Salmon R	7	14	*	Based only on Lambda ≥ 1.0
Lower Valley Ck	3	10	*	Based only on Lambda ≥ 1.0
Moose Ck	0	0	*	Based only on Lambda ≥ 1.0
Newsome Ck	0	0	*	Based only on Lambda ≥ 1.0

Table 9.7-17 (Continued). Estimated percentage change in additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA. Low and High estimates are based on a range of assumptions, as described in the text. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the proposed action, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

Spawning Aggregation	Needed Survival Change Low	Needed Survival Change High	
Red R	10	18	* Based only on Lambda ≥ 1.0
Salmon R E Fk	0	2	* Based only on Lambda ≥ 1.0
Salmon R S Fk	0	0	* Based only on Lambda ≥ 1.0
Secesh R	0	0	* Based only on Lambda ≥ 1.0
Selway R	8	15	* Based only on Lambda ≥ 1.0
Sheep Cr	97	110	* Based only on Lambda ≥ 1.0
Upper Big Ck	0	0	* Based only on Lambda ≥ 1.0
Upper Salmon R	13	21	* Based only on Lambda ≥ 1.0
Upper Valley Ck	0	0	* Based only on Lambda ≥ 1.0
Wallowa Ck	42	51	* Based only on Lambda ≥ 1.0
Wenaha R	14	66	* Based only on Lambda ≥ 1.0
Whitecap Ck	14	22	* Based only on Lambda ≥ 1.0
Yankee Fork	26	35	* Based only on Lambda ≥ 1.0
Yankee West Fk	0	0	* Based only on Lambda ≥ 1.0
<u>Snake River Fall Chinook</u>			
Aggregate	0	44	
<u>Upper Columbia River Spring Chinook</u>			
ESU Aggregate - CRI	32	58	
Methow River-QAR	24	41	
Entiat River-QAR	36	55	
Wenatchee R.-QAR	51	116	
Methow River-CRI	32	90	
Entiat River-CRI	32	119	
Wenatchee R.-CRI	84	178	
<u>Upper Willamette River Chinook</u>			
McKenzie River above Leaburg Dam	9	65	

Table 9.7-17 (Continued). Estimated percentage change in additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA. Low and High estimates are based on a range of assumptions, as described in the text. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the proposed action, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

	Needed Survival Change		
Spawning Aggregation	**Low**	**High**	
Lower Columbia River Chinook			
Aggregations Above Bonneville Dam:			
(Insufficient information for analysis)			
Aggregations Below Bonneville Dam:			
Bear Creek	114	213	
Big Creek	31	97	
Clatskanie	193	312	
Cowlitz Tule	33	99	* Based only on recovery metric.
Elochoman	4	56	* Based only on recovery metric.
Germany	30	95	* Based only on recovery metric.
Gnat	107	195	
Grays Tule	76	164	* Based only on recovery metric.
Kalama Spring	87	180	* Based only on recovery metric.
Kalama	6	58	* Based only on recovery metric.
Klaskanine	130	227	
Lewis R Bright	5	11	* Based only on recovery metric.
Lewis Spring	46	120	* Based only on recovery metric.
Lewis, E Fk Tule	3	3	* Based only on recovery metric.
Lewis and Clark	934	1,493	
Mill Fall	144	258	
Plympton	21	82	
Sandy Late	7	9	
Skamokawa	105	208	* Based only on recovery metric.
Youngs	573	732	
Snake River Steelhead			
ESU Aggregate	58	260	
A-Run Aggregate	44	214	
A-Run Pseudopopulation	44	214	
B-Run Aggregate	92	333	
B-Run Pseudopopulation	92	333	

Table 9.7-17 (Continued). Estimated percentage change in additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA. Low and High estimates are based on a range of assumptions, as described in the text. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the proposed action, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

	Needed Survival Change		
Spawning Aggregation	**Low**	**High**	
Upper Columbia River Steelhead			
ESU Aggregate - CRI	26	193	
Methow - QAR	0	110	
Wenatchee/Entiat - QAR	0	67	
Mid-Columbia River Steelhead			
ESU Aggregate	92	218	* Based only on recovery metric.
Deschutes R Sum	102	226	
Warm Springs NFH Sum	36	36	
Umatilla R Sum	31	27	
Yakima R Sum	0	0	
Upper Willamette River Steelhead			
ESU Aggregate	37	69	
Molalla	45	108	
N Santiam R	42	58	
S Santiam	30	78	
Calapooia	53	53	
Lower Columbia River Steelhead			
ESU Aggregate	53	171	* Based only on recovery metric.
Aggregations Above Bonneville Dam:			
(Insufficient information for analysis)			
Aggregations Below Bonneville Dam:			
Clackamas Sum	144	376	
Clackamas Win	75	243	
Green River Win	80	80	
Kalama Sum	51	267	
Kalama River Win	13	58	

Table 9.7-17 (Continued). Estimated percentage change in additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after implementing the RPA. Low and High estimates are based on a range of assumptions, as described in the text. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the proposed action, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

	Needed Survival Change		
Spawning Aggregation	**Low**	**High**	
Sandy Win	49	108	
Toutle Win	81	81	
Columbia River Chum Salmon			
ESU Aggregate	0	0	* Based only on recovery metric.
Aggregations Above Bonneville Dam:			
(Insufficient information for analysis)			
Aggregations Below Bonneville Dam:			
Grays R west fork	0	0	
Grays R mouth to head	18	18	
Hardy Creek	0	0	
Crazy Johnson	0	0	
Hamilton	36	36	
Hamilton Springs	0	0	

naturally. The harvest actions will cap harvest rates at current levels, allowing time for other recovery measures to take effect.

Each set of actions is expected to benefit Columbia basin salmonids, although measures that address hydrosystem passage will clearly benefit the upper river chinook salmon and steelhead ESUs, SR sockeye salmon, and MCR steelhead more than the lower river ESUs. In the short term, benefits to the lower river ESUs will result primarily from the habitat, harvest, and hatchery actions. In the long term, ongoing studies may link the effects of FCRPS flow management to elements of critical habitat in the estuary and plume. These studies may lead to additional hydro actions (i.e., through comprehensive 5- and 8-year check-ins [Sections 9.1.5 and 9.5]) that provide high survival benefits to all 12 ESUs.

Table 9.7-18. Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
SR spring/summer chinook	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**Inriver migrants:** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Inriver survival increases by ~9% due to passage improvements at 8 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions and reduced delay** **- Potential for reduced delayed mortality due to FCRPS passage** **Transported fish:** **- Potential for reduced delayed mortality** *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Potential habitat degradation in the plume** *- Hatchery reforms may reduce adverse interactions with wild fish* *- Potential reduction in incidental take to reduce ocean harvest*	**- Expected 6% increase in survival during passage through 8 FCRPS projects** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Potential indirect improvement in spawning rate success** *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
SR fall chinook	**<u>Inriver</u> migrants:** **- Flows and water quality (temperature) improve during summer and early fall in the Snake River due to additional cold water releases from Dworshak Reservoir** **- Inriver survival increases by ~5% due to passage improvements at 8 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions and increased summer flows** **- Potential for reduced delayed mortality due to FCRPS passage** **<u>Transported</u> fish:** **-Improved transportation due to extended barging** **-Potential for reduced delayed mortality** *- Hatchery reforms may reduce adverse interactions with wild fish*		*- Acquire, protect, and restore high quality estuarine habitat* *- Hatchery reforms may reduce adverse interactions with wild fish* *- Potential reduction in incidental take to reduce ocean harvest*	**-Expected 11% increase in survival during passage through 8 FCRPS projects** **- Water quality (temperature) improves during summer and early fall in the Snake River due to additional cold water releases from Dworshak Reservoir** **- Potential indirect improvement in spawning rate success** *- Potential reduction in incidental take to reduce mainstem harvest*	**- Unknown effects of flow management on use of spawning habitat below Lower Granite, Little Goose, and Ice Harbor dams** *In the lower Snake mainstem:* *- Protect productive habitat* *- Address flow and passage problems* *- Improve/restore degraded habitat* *- Hatchery reforms may reduce adverse interactions with wild fish*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
UCR spring chinook	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Inriver survival increases by ~9% due to passage improvements at 4 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions and reduced delay** **- Potential for reduced delayed mortality due to FCRPS passage** - Mortality due to passage past up to 5 PUD projects *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Potential habitat degradation in the plume** *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Expected 3% increase in survival during passage through 4 FCRPS projects** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Potential indirect improvement in spawning rate success** - Mortality due to passage past up to 5 PUD projects *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*
UWR chinook	*In the McKenzie subbasin:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill**	*- Acquire, protect, and restore high quality estuarine habitat* *- Hatchery reforms may reduce adverse interactions with wild fish* *- Potential reduction in incidental take to reduce ocean harvest*	*In the McKenzie subbasin:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	*In the McKenzie subbasin:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
LCR chinook	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Inriver survival increases by ~5% due to passage past Bonneville Dam for a limited number of subbasin populations**	*- Acquire, protect, and restore high quality estuarine habitat* *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Expected 1-2% increase in survival during passage past Bonneville Dam for a limited number of subbasin populations** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill**	**- Access to and quantity and quality of habitat at Ives Island restricted by FCRPS flows** *In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Development	Adult Migration Corridor	Spawning Habitat
SR steelhead	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**<u>Inriver</u> migrants:** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Inriver survival increases by ~9% due to passage improvements at 8 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions and reduced delay** **- Potential for reduced delayed mortality due to FCRPS passage** **<u>Transported</u> fish:** **- Potential for reduced delayed mortality** *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Potential habitat degradation in the plume**	**- Expected 5-6% increase in survival during passage through 8 FCRPS projects** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Potential indirect improvement in spawning rate success** *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
UCR steelhead	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- <u>Inriver</u> survival increases by ~9% due to passage improvements at 4 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions and reduced delay** **- Potential for reduced delayed mortality due to FCRPS passage** - Mortality due to passage past up to 5 PUD projects *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Potential habitat degradation in the plume**	**- Expected 3% increase in survival during passage through 4 FCRPS projects** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Potential indirect improvement in spawning rate success** - Mortality due to passage past up to 5 PUD projects *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
MCR steelhead	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- <u>Inriver</u> survival increases by ~9% due to passage improvements at 4 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions and reduced delay** **- Potential for reduced delayed mortality due to FCRPS passage**	**- Potential habitat degradation in the plume**	**- Expected 3% increase in survival during passage through 4 FCRPS projects** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Potential indirect improvement in spawning rate success** *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*
UWR steelhead	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** *- Hatchery reforms may reduce adverse interactions with wild fish*	*- Acquire, protect, and restore high quality estuarine habitat* *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
LCR steelhead	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Inriver survival increases by ~4% due to passage improvements at Bonneville Dam for a limited number of subbasin populations**	**- Potential habitat degradation in the plume** *- Hatchery reforms may reduce adverse interactions with wild fish*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Expected 1% increase in survival during passage past Bonneville Dam for a limited number of subbasin populations** *- Potential reduction in incidental take to reduce mainstem harvest*	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*
CR chum	*In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*	**- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Inriver survival increases by ~5% due to passage past Bonneville Dam for a limited number of subbasin populations**	*- Acquire, protect, and restore high quality estuarine habitat*	**- Expected 1-2% increase in survival during passage past Bonneville Dam for a limited number of subbasin populations** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** *- Potential reduction in incidental take to reduce mainstem harvest*	**- Access to Hamilton Creek and Spring Channel improved by FCRPS flows** **- Access to, quantity of, and quality of habitat at Ives Island restricted by FCRPS flows** *In three priority subbasins:* *- Protect productive habitat* *- Address flow, passage, and screening problems* *- Improve/restore degraded habitat*

Table 9.7-18 (Continued). Summary of expected effects of RPA on critical habitat at species-level. Effects in action area shown in **bold**. Effects of offsite mitigation shown in *italics*.

ESU	Juvenile Rearing Areas	Juvenile Migration Corridors	Areas - Growth/Develop	Adult Migration Corridor	Spawning Habitat
SR sockeye	N/A	**Inriver migrants:** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** **- Survival increase due to passage improvements at 8 FCRPS projects** **- Expected 10% reduction in reservoir mortality due to predator control actions** **- Potential for reduced delayed mortality due to FCRPS passage** **Transported fish:** **- Potential for reduced delayed mortality**	**- Potential habitat degradation in the plume**	**- Expected ~1% increase in survival during passage through 8 FCRPS projects** **- Deflector optimization improves water quality (dissolved gas) during involuntary spill** *- Potential reduction in incidental take to reduce mainstem harvest*	N/A

9.7.3 Evaluation of Snake River Four-Dam Breach in Comparison to the RPA

Sections 9.7.1 and 9.7.2 reviewed the action-area and species-level effects of the hydrosystem components of the RPA, given concurrent expectations of survival in other life stages resulting from a continuation of current harvest rates and implementation of the Mid-Columbia HCP. For several ESUs, significant additional changes in survival are necessary, beyond those expected from implementation of the hydrosystem components of the RPA. Effects of expected improvements in other parts of the life cycle that were not captured in Section 9.7.1 are described in the Basinwide Recovery Strategy and are summarized in Section 9.7.2. The qualitative results of these sections suggest that a significant portion of the needed additional survival changes is likely to be achieved through ongoing federal activities and implementation of the off-site mitigation component of the RPA.

Regional debate in recent years has focused on the advisability of breaching four Snake River dams as an alternative to hydrosystem operations similar to those described in the RPA. This section provides an analysis of the effects of this action, to place the effects of the RPA in the context of the primary alternative option that has been discussed within the region.

This analysis is presented, in part, to demonstrate the effects of critical uncertainties on the estimated survival changes associated with breaching four Snake River dams. It is presented to support the possible future need to implement dam breaching following 5- and 10-year reviews (Section 9.5) of species' status, effectiveness of RPA measures, and new research results that may resolve some of the key uncertainties associated with effectiveness of breaching. This analysis supports the elements of the RPA that may require continued engineering and other preparations for possible future breaching.

9.7.3.1 Effects of Snake River Four-Dam Breach on Action Area Biological Requirements

In its report "Return to the River," the Independent Scientific Group (ISG 1996) calls for the reestablishment of "normative" ecosystem features of the Columbia and Snake rivers and tributaries that are essential to salmon restoration. The term "normative" describes a condition that provides "essential ecological conditions and processes needed to maintain diverse and productive salmonid populations." The ISG characterizes the normative river as a continuum of conditions ranging from slightly better than current at one end of the spectrum to nearly pristine on the other. The ISG asserts that only by approaching more normative ecosystem conditions would recovery goals for salmonids be attained. Moreover, sustained productivity will require a network of complex and interconnected habitats that are created, altered, and maintained by natural physical processes in freshwater, the estuary, and the ocean (ISG 1996).

Natural river drawdown of the four Federal hydroprojects on the lower Snake River could reestablish a continuum of riverine habitat. Drawdown to natural river level of the four lower Snake River reservoirs is expected to improve conditions for both juveniles and adults of some salmonid species by exposing more of the shoreline and allowing the river to redistribute gravel and nutrients, thereby restoring spawning, rearing, and feeding habitat. It is also expected to increase the connectivity of channel, groundwater, floodplain, and upland components of the catchment ecosystem and create more diverse, high-quality habitat, which is crucial for salmonid spawning, rearing, migration, maintenance of food webs, and predator avoidance (ISG 1996).

9.7.3.1.1 Dam Passage Survival During Removal and Transition Periods. The Corps has developed a tentative schedule for breaching the four lower Snake River dams (Corps 1999c [feasibility report/EIS and Appendix D]). After receiving congressional authorization, the Corps estimates that the project would be completed in 8 or 9 years, with drawdown of Lower Granite and Little Goose reservoirs in year 5 or year 6, and drawdown of Lower Monumental and Ice Harbor reservoirs in the following year. During this 2-year removal period, each of the four reservoirs would be drawn down to natural river level during the months of August through December. The Corps predicts a 3- to 8-year transition period after drawdown is complete, during which major changes in the riverine environment — such as sediment scour and redeposition and the redistribution of predators — would stabilize. During the transition period, mortality rates of juvenile and adult salmon and steelhead may be affected by these factors, as well as deviation from normal operations at the dams. For example, normal operations would not be possible during transition from full pool to riverine conditions (August to December). Turbines would operate at less than maximum efficiency, spill conditions would be altered, and transportation of fish would not be possible. All of these conditions could increase mortality of fall chinook and sockeye outmigrating during the 2-year removal period.

Under the Corps' drawdown plan in the draft feasibility report/EIS, turbines would be modified before the 2-year removal period so that they could be operated under the unusual low-head conditions for primary discharge while the reservoirs are lowered. As a result, up to 3 units per project would not be available during part of the preceding spring spill season, and the reduced powerhouse capacity could result in increased spill and potentially undesirable TDG levels in the river downstream. NMFS expects that these effects, if they occur, would be transitory and would most likely occur during May (Table 9.7-19).[3] Effects of elevated TDG could be severe if flows are unusually high while the powerhouse is running under reduced capacity.

[3] The analysis shown in Table 9.7-19 suggests that the Corps should schedule turbine retrofits such that work is completed by April 1 of each year, to minimize potential TDG problems.

Table 9.7-19. Estimated safe discharge[1] and probability of involuntary occurrence of flows exceeding this level under existing project capacities and under project capacities estimated to exist while the three low-capacity turbines are being replaced at each lower Snake River project.

	Current Conditions				Replacement-year Conditions			
	Total Safe Discharge	Probability of Exceedence (%)			Total Safe Discharge	Probability of Exceedence (%)		
Project	(kcfs)	April	May	June	(kcfs)	April	May	June
Lower Granite	178.8	0	2	2	126	8	25	27
Little Goose	162.3	4	6	8	110.4	22	41	33
Lower Monumental	162.7	4	6	8	105.1	29	45	21
Ice Harbor	198.9	0	0	2	161.4	4	8	8

1 Safe discharge is the discharge that would result in 120% TDG downstream from each project assuming maximum powerhouse capacity and known project TDG characteristics.

Removal and Transition Period Effects on Juvenile Salmon. During the removal period, conditions at the dams (i.e., at juvenile bypass systems) would be outside the criteria of systems designed to improve the passage survival of migrating juvenile salmon and steelhead. By scheduling the dam breaching process between August and December, when relatively few juveniles are passing the projects, the Corps would minimize potential adverse effects on most Snake River ESUs. Some juvenile fall chinook salmon, those rearing or overwintering in the reservoirs, could become stranded in pools when the reservoir elevations are reduced. These potential short-term and transitory adverse effects are difficult to quantify but could affect two year-classes.

Removal and Transition Period Effects on Adult Salmon. Three factors could influence the success of adult salmon and steelhead migration during the removal period and early in the transition period: suspended sediment concentrations, passage around breach and shoreline protection structures, and access into tributaries.

Suspended sediment concentrations would be elevated during drawdown (August through December work period) and then, with decreasing intensity, during subsequent spring freshets (April through June) for several years (the transition period). During removal operations, high concentrations of suspended sediment may cause increased delays and straying of fall migrants (fall chinook salmon and steelhead). Also, spring and summer chinook salmon could be delayed or could be caused to stray by turbidity events during subsequent spring freshets.

Upstream passage facilities at the dams would be inoperable during the fall/winter periods when dams are breached. This period encompasses most of the fall chinook and steelhead migrations. Specific actions would be implemented to ensure that adult fish move upstream. Under the current two-tiered, two-dam removal plan, the Corps recommends that adult fish be transported by truck around the construction reaches. Adults would probably be collected at Ice Harbor and Little Goose dams, respectively, during the two removal periods. Separating Lyons Ferry or

Tucannon River adults from adults destined for tributaries above Lower Granite would be of concern to NMFS during this trap and haul operation.

Adult movement past the former dam sites would probably not be impeded during the transition period or thereafter. Under current conditions in the lower Snake River, adults typically stop migrating when flows reach 170,000 cfs. Flows of this magnitude are expected to occur only for a brief period once every 5 years on average (Corps 1999c). The Corps would develop the breach areas around each dam such that river velocities up to the 170,000 cfs flow level would not impede adult passage. The following Corps' criteria for adult passage through the new channels are based on published information about fish behavior and modeled velocity conditions in the breach area (Corps 1999c [Appendix D]):

- Channel velocities below 1.5 meters per second (m/s) (5 feet per second [ft/s]) require no supplemental fish passage features.
- Higher channel velocities require features in the river that provide rest areas.
- As velocities increase above 1.5 m/s, the density of required rest areas increases.

The Corps will use model studies to determine the extent of appropriate rest structure layout during the next stage of the design process (Corps 1999c [Appendix D]).

In summary, NMFS finds that the greatest potential risk of reduced survival of juvenile and adult salmon and steelhead would occur during and immediately after the 2-year dam removal period. Risk would decrease each subsequent year as environmental conditions stabilize. The SR fall chinook salmon ESU appears to be most vulnerable to drawdown effects because at least part of both the juvenile and adult migration periods coincides with the August to December drawdown period. The risk to adults would be reduced by the Corps' planned trap-and-haul operation, but subsequent indirect effects of this operation are unknown. NMFS concludes that there is not sufficient information currently available to quantify these risks. If the Corps obtains congressional authorization to breach the lower Snake River dams, NMFS would recommend that the Corps develop detailed operations and demolition plans for the projects and consult with NMFS and USFWS on those plans.

9.7.3.1.2 Effects of Breaching on Sedimentation and Fluvial Geomorphology. Over time, breaching the four lower Snake River dams would restore riverine conditions to what is currently a series of impounded reservoirs. Rivers exist in dynamic equilibrium with the environmental forces that form them, including the hydrologic regime, underlying geology, and sediment supply. Whereas other multipurpose developments (e.g., flood control and irrigation) upstream from Lower Granite Dam have somewhat changed the hydrologic regime in the lower Snake River, sediment yields and channel-forming flows appear to be little changed (Corps 1999c

[Appendix H]).[4] These observations, combined with the fact that the lower Snake River is confined within a basalt gorge, lead NMFS to conclude that, following dam removal, a river greatly resembling the pre-dam Snake River would emerge. The rate at which this likely outcome would occur would depend on sediment transport and thus on river discharge and channel form, properties that are difficult to forecast with precision. The Corps predicts that the bulk of the morphological changes would occur during the first decade after dam removal, as sediment deltas in the reservoirs erode (Corps 1999c [Appendix H]).

Estimates of the amount of sediment stored in reservoirs upstream from Ice Harbor Dam range from 100 to 150 million cubic yards (Corps 1999c [Appendix H]), with the majority stored in Lower Granite Reservoir (72 to 96 million cubic yards). About half this stored sediment would be transported out of the Snake River basin within the first few years following breaching (Corps 1999c [Appendix H]). Much of the accumulated sediment that would remain currently covers areas that would become uplands after dam removal, where the erosive forces of the river would become slight to nonexistent. These deposits would be recolonized and stabilized by vegetation and could become relatively permanent features on the landscape. Sediments stored in the active channel would mobilize and be redeposited in accordance with their size relative to the erosive energy of the stream. Sand and finer particles would be readily mobilized and either move as a bedload or become suspended in the water column and move as part of the river's suspended sediment load. These small particles would be deposited in relatively quiescent areas, primarily along the river's shoreline, or would be transported through the Snake River to the Columbia River confluence and beyond. Gravel and larger particles would move primarily as bedload and be sorted and deposited in accordance with local conditions (shear stress). Large particles are the most difficult to move and would tend to dominate the fastest water as smaller particles were washed away. Bedload transport would virtually stop at Lake Wallula (Columbia River confluence), and a substantial sediment deposit would form along the shoreline downstream from the Snake River confluence and other quiescent and backwater areas between the confluence and McNary Dam (Corps 1999c, Appendix H). These deposits are expected to be 3 feet deep or less.

Erosion of the sediment body presently located in Lower Granite Reservoir would be severe near the face of the existing sediment delta (between RM 110 and RM 122). A single channel would rapidly emerge as the particles at its base were transported away and the channel rapidly cut upstream. This downcutting would leave portions of the sediment body perched above the active channel, forming steep banks. Subsequent high flows that fill the channel would flatten the banks. These effects would probably occur within 1 or 2 years of dam removal, assuming near-normal streamflow conditions. Due to the large sediment supply, the channel in and immediately downstream from this sediment body would be subject to the greatest changes in bedform, including tendencies to form islands and large bars.

After dam breaching, the annual sediment yield upstream from Lower Granite Dam would pass unimpeded through the lower river, replenishing gravels and adding to turbidity events. This

[4] Channel bedform changes almost continually over a wide range of discharges. However, as the product of the probability of occurrence and the channel-forming forces exerted, bank full discharge (or the 1.5- to 2-year return period flood) is generally accepted to represent the dominant channel-forming flow.

would add about 3 to 4 million cubic yards to the river's sediment load (Corps 1999c [Appendix H]). These effects would be permanent.

Suspended sediment concentrations in the lower Snake and Columbia rivers would also increase after breaching, as demonstrated during the 1992 partial drawdown test in Lower Granite Reservoir. Suspended sediment concentrations increased from a background level of 9.5 parts per million (ppm) to a high reading of 1,928 ppm. However, the highest concentrations occurred soon after drawdown and declined rapidly; most measurements were lower than 510 ppm (USFWS 1999). The Corps estimates that concentrations as high as 9,000 mg/l might occur immediately following breaching at Ice Harbor Dam (Corps 1999c).

Suspended sediment concentrations would be highest during the first few years following dam breaching and the exposure of the sediment body to the erosive force of the river. Annual peaks would occur immediately after breaching and drawdown operations (August to December) and then again during the spring freshet (April through June). This seasonal flushing would continue several years after removal, but with decreasing intensity (Corps 1999c).

Suspended sediment concentrations would increase permanently as upstream suspended sediment loads pass through the river. It is anticipated that within a decade after dam breaching operations were complete, suspended sediment loads in the affected reach would approximate incoming loads from the upper basin (Corps 1999c, Appendix H).

Effects of Sedimentation and Changes in Fluvial Geomorphology on Juvenile Survival. The expected increase in suspended sediment concentrations following dam breaching (between 2,000 and 9,000 milligrams per liter (mg/l) during part of the spring freshet), in each of several years after breaching could affect juvenile salmonid survival. Salmon and steelhead smolts are known to survive suspended sediment concentrations as high as 20,000 mg/l (Sigler et al. 1984). However, some researchers have observed juvenile salmon mortalities at suspended sediment concentrations as low as 500 mg/l (Waters 1995). Thus, some direct mortality of migrating juveniles is likely during peak suspended sediment events (corresponding with the rising limb of the spring freshet hydrograph). However, such effects would be transitory (a few weeks) and would only affect a fraction of several subsequent juvenile migrations. While the Corps has analyzed the chemical characteristics of some sediment cores, NMFS expects that a much more thorough sampling effort would be carried out before drawdown to ensure that resuspended sediments are not toxic or deleterious to aquatic life.

Given that increasing turbidity reduces the capture efficiencies of visually-oriented predators like smallmouth bass, northern pikeminnows, gulls, and terns (NMFS 2000f), predation rates would probably be reduced by post-drawdown increases in suspended sediment concentrations. However, this effect could be offset somewhat by an increased predator density (at least temporarily) following dam removal, as the assemblage of fishes now occupying the reservoirs vies to occupy smaller volumes of suitable habitat (Corps 1999c).

<u>Effects of Sedimentation and Changes in Fluvial Geomorphology on Spawning Habitat</u>. Two potential biological effects of the morphological changes likely to occur following breaching are increased spawning habitat in the mainstem Snake River, and passage barriers at tributary mouths.

In the short term, breaching activities would disrupt tailrace spawning habitat for fall chinook that currently occurs below Lower Granite and Little Goose dams. At the same time, new spawning habitat would emerge.

In the rapid erosion zone (RM 110 to RM 122) there is some risk that established redds would be subsequently scoured, buried, or dewatered as the channel form changes in the first few years following dam removal. Because few fish are expected to use this habitat during the breaching and transition period, such potential adverse effects are expected to be minor and short-term.

Mainstem spawning habitat would reemerge between RM 10 (the current site of Ice Harbor) to RM 140 (upper end of Lower Granite Reservoir) and would probably be enhanced by a plentiful sediment supply for decades following dam breaching. The Corps (1999c [Appendix H]) estimated that suitable fall chinook spawning habitat in the lower Snake River could increase from 226 acres under current conditions to 3,521 acres following breaching, an almost 16-fold increase. Although this would be a substantial increase in fall chinook spawning habitat, at the current depressed numbers of spawning adults, available spawning habitat is not limiting the population.

Currently accessible tributary habitat may become inaccessible due to the exposure of large sediment fans at the tributary mouths. During 30-plus years of impoundment, sediment has accumulated and formed deltas where tributaries enter the lower Snake River reservoirs. Following drawdown, these deltas would impede upstream fish passage until the streams move sediment back into the original riverbed or the sediment is moved by mechanical means. Schuck (1992) observed a large deposit of sediment at the mouth of Alpowa Creek during the 1992 Lower Granite Reservoir drawdown test and noted a vertical bedform at the mouth of this stream that would have been impassable to steelhead. Tributary sediment deltas are expected to erode rapidly, but human intervention may be necessary to ensure access to all suitable spawning habitat.

9.7.3.1.3 Estimated Juvenile Survival Following Transition Period. After a natural channel configuration has developed in the 210-km reach and riparian vegetation has become established, NMFS expects that juvenile survival rates will approximate the rates observed in free-flowing reaches above the head of Lower Granite pool. Estimates of survival from the Salmon River trap at Whitebird to Lower Granite Dam are available for wild spring chinook salmon during 1966 through 1968 (Raymond 1979) and for wild spring/chinook salmon and steelhead during 1993 through 1998 (Smith et al. 1998; Hockersmith et al. 1999; Smith et al. 2000). The estimates for both periods include survival through Lower Granite Reservoir. Those for the recent period also include survival past Lower Granite Dam. Using the methods described in Appendix A to factor out the reservoir and dam mortality, NMFS calculates an average per-km survival rate through the free-flowing stretch of 0.999689614 per km for spring chinook and 0.999656 per km for steelhead. Interannual variation was high (Appendix A). The average estimates can be expanded to survival through the entire 210-km reach, resulting in a mean reach survival of 92.2% for SR spring/summer chinook salmon and 93.0% for steelhead (Table 9.7-19). These estimates compare to a range of 85% to 95% estimated by the PATH team (Marmorek et al. 1998). The PATH estimates ranged from historical Whitebird trap estimates (95%) to combined Whitebird and Imnaha trap estimates for the period 1993 through 1996 (85%).

NMFS did not incorporate the Imnaha trap or other Salmon River traps into the estimates. Traps in the Salmon River above Whitebird were not used in estimates for the following reasons:

- The estimates are already captured in the Whitebird to Lower Granite estimate, because it includes fish from all of the tributaries caught at the upstream traps.

- The Whitebird estimate is through a river reach that is more similar to the reach below Lower Granite Dam (in terms of river width and depth and flow characteristics) than are the reaches further up in the tributaries. The Imnaha trap is in a tributary habitat that is more dissimilar to the reach below Lower Granite Dam than is the Whitebird trap.

- The upstream traps are closer to spawning areas, so survival rates from those traps probably represent a culling process that would be greater than that included in the survival rate below Whitebird. To elaborate, culling may result from size, degree of smoltification, or river stretches through which the smolts migrated. These stretches are likely to be more dissimilar among Lower Granite and tributary smolts than among Lower Granite and Whitebird smolts. Imnaha trap estimates were not used because the trap is closer to the spawning grounds than is the Whitebird trap.

To test the hypothesis that survival is lower in reaches closer to spawning grounds than in reaches farther downstream, survival of Whitebird and Imnaha releases was compared in the reach between each trap and Lower Granite Dam and in two reaches below Lower Granite Dam (Appendix A). Survival between the Imnaha trap and Lower Granite Dam, expressed as a per-km rate, was much lower than between the Whitebird trap and Lower Granite Dam, whereas survival estimates for the two traps were nearly identical when compared between Lower Granite Dam and Little Goose Dam, and between Little Goose Dam and Lower Monumental Dam. This suggests that after initial losses of fish occur, there are no inherent differences in smolt survival between stocks released at Imnaha and Whitebird. Thus, the Whitebird trap provides the best estimates of expected survival in downstream stretches of natural river.

The estimates of survival through the breached section of the Snake River can be combined with estimates of survival through the four lower Columbia River projects to derive an estimate of system survival after the drawdown transition period has passed. Estimates of SR spring/summer chinook survival through the four lower Columbia River projects are shown in

Table 9.7-1.[5] Inriver survival from McNary to Bonneville dams would average 66.4%. When survival through the free-flowing reach in the lower Snake River is combined with survival through the impounded reach in the lower Columbia River, system survival of SR spring/summer chinook salmon is expected to average 61.2% (Table 9.7-20). Using a similar method (and data shown in Table 9.7-1) for steelhead, system survival for juveniles from this ESU is expected to average 63% (Table 9.7-20).

Table 9.7-20. Estimates of juvenile survival for three Snake River ESUs following a transition period after breaching four Snake River dams.

ESU	Avg Survival/Km Through Free-Flowing Reach	Survival Through 210-km Reach After 4-Dam Breach	Lower River (MCN to BON) Survival	Total System Survival After 4-Dam Breach
SR spr/sum chinook salmon	99.9614%	92.2%	66.4%	61.2%
SR fall chinook				
Method A	99.78%	63.0%	37.7%	23.8%
Method B	99.95%	90.0%	37.7%	34.0%
SR Steelhead	99.9656%	93.0%	67.7%	63.0%

Empirical estimates of free-flowing reach survival for juvenile SR fall chinook salmon is more limited and difficult to interpret. The PATH participants used two methods to group and extrapolate recent PIT-tag survival estimates (Peters et al. 1999). The first (hereafter called Method A) results in a free-flowing survival rate of 0.9978 per km, and the second (Method B) in a rate of 0.9995 per km. NMFS finds that both methods are credible and that there is no basis for concluding that one better represents the best available scientific information than the other. Therefore, NMFS uses both methods and establishes a range of likely survival estimates. When expanded to the 210-km reach, Method A estimates an average survival of 63.0% versus 90.0% for Method B (Table 9.7-20). Using a method similar to that applied to SR spring/summer chinook salmon, and the data shown in Table 9.7-1 for the survival of fall chinook salmon through the lower Columbia reach, the system survival of juvenile Snake River fall chinook is expected to average 23.8% with Method A and 34% with Method B (Table 9.7-20).

NMFS has not estimated the survival of juvenile Snake River sockeye salmon through free-flowing river reaches or through the four lower Columbia River projects under the RPA. Based on the similar size and migration timing of juvenile sockeye salmon, yearling chinook salmon, and steelhead, it is likely that a four-dam breach will result in Snake River sockeye survival that is similar to that estimated for the other two spring migrating ESUs (approximately 60%, on

[5] NMFS assumes that juvenile fish would not be transported from McNary Dam if the Snake River dams are breached.

average). Breaching four dams in the Snake River will not change the estimates of juvenile survival for ESUs spawning outside of the Snake River basin, so NMFS applies the juvenile survival rates associated with the RPA.

9.7.3.1.4 Estimated Adult Survival Following Transition Period. After a natural channel configuration has developed in the 210-km reach and riparian vegetation has become established, NMFS expects that adult survival rates through the lower Snake River will approximate the rates observed in free-flowing reaches above the head of Lower Granite pool.

The PATH participants estimated free-flowing survival of wild SR spring/summer chinook salmon by applying the absolute difference in Bjornn's (1989) mean dam-count to redd-count ratios at Ice Harbor Dam for two periods, 1962 through 1968 and 1975 through 1988 (Marmorek et al. 1998). Ice Harbor was the furthest upstream hydroproject during the first period. The difference between the mean ratios for each period estimates the effect of the three dams that were constructed above Ice Harbor during the latter period (1975 through 1988). Extrapolating Bjornn's result over all four dams, the estimate of survival of adult spring/summer chinook salmon traversing the post-drawdown reach between the current location of the tailrace of Ice Harbor Dam and the head of Lower Granite pool would be 97% (i.e., 99% per-project). This method assumes that survival from the current location of the head of Lower Granite pool to the various spawning areas did not change between the two periods. In applying this method, NMFS assumes that survival through the four-dam lower Snake reach, as currently configured and operated, is equivalent to survival through that reach during the 1975 through 1988 period. In fact, recent reach survival studies indicate survival rates have improved with changes in FCRPS configuration and operations (NMFS 2000e), suggesting that this method may overestimate survival through a free-flowing lower Snake River reach if the dams were removed.

An alternative method is to evaluate the survival of radio-tagged adults through free-flowing reaches above Lower Granite Dam, in a manner similar to that used to estimate juvenile survival. Bjornn et al. (1995) estimated adult loss of spring chinook salmon from Ice Harbor Dam to reference points in tributaries to the Snake River above Lower Granite Dam. NMFS estimated survival from Ice Harbor to Lower Granite and adjusted total survival rates to derive estimates of survival through the free-flowing reach, using methods documented in Table 6.1-1. The resulting survival rate was 0.994 per km, equal to 88.2% (97% per-project) survival through the 210-km reach that would be affected by breaching four lower Snake River dams. In using this approach, NMFS made numerous assumptions to adjust the original empirical estimates of adult loss. NMFS also assumed that any delayed effects of passing eight dams before entering the free-flowing reach above Lower Granite Dam would be equivalent to the delayed effects of passing only four dams following breaching.

This second method may underestimate survival of adults through free-flowing river sections. In addition to consideration of the assumptions described above, comparison of the estimate of survival generated by the second method with estimates of survival under current conditions (Table 6.1-7) indicates that this method predicts lower adult survival under free-flowing conditions (88.2%) than under impounded conditions ($0.976^4 = 90.8\%$). Although adults travel through impounded sections of the Snake River at approximately the same speed as they travel through free-flowing reaches (e.g., Bjornn et al. 1998, NMFS 2000e), it is not clear that survival rates through impounded and unimpounded reaches are equivalent.

NMFS considers the best estimate of adult spring/summer chinook survival following breaching to be intermediate to estimates derived from the two methods described above. The survival rate expected to result from the RPA represents survival through an impounded reach with all possible improvements short of breaching. The estimate of adult survival, when the RPA is fully implemented, is 98% per project, intermediate to the survival rate estimated by the first and second methods (97% and 99% per project, respectively). Using the preferred method, expected survival of adult SR spring/summer chinook through the FCRPS, without breaching, is 85.5% (Table 9.7-2).

One advantage of the method used for estimating the survival of SR spring/summer chinook salmon is that it is directly applicable to other ESUs, whereas the other two methods are not. Therefore, estimates of adult survival for all ESUs are as described in Table 9.7-2. The expected survival rates are 74% for SR fall chinook salmon, 80.3% for steelhead, and 88.7% for SR sockeye salmon.

9.7.3.2 Analysis of Effects of Snake River Four-Dam Breach on Biological Requirements Over Full Life Cycle

Quantitative analyses were possible for three of the four Snake River ESUs that would be affected by breaching Snake River dams. Details of the analyses used to evaluate the effects of the proposed action on biological requirements over the full life cycle are described in Appendix A. Specifics of the analyses for each ESU are nearly identical to those described in Section 6.2.1. Results are summarized for the three Snake River ESUs in the following sections.

9.7.3.2.1 Snake River Spring/Summer Chinook Salmon

NMFS evaluated the same populations and used the same general approach as that described in Section 9.7.2.1. The necessary improvements in survival from average base period conditions were also as described in Section 9.7.2.1.

A key uncertainty associated with dam breaching is the effect that it will have on survival below Bonneville Dam (e.g., Marmorek and Peters 1998, Peters et al. 1999, Kareiva et al. 2000). Although it is likely that some actions called for by the RPA will improve fish conditions and survival below Bonneville Dam, NMFS conservatively assumed that there would be no effect of the proposed action (Section 6.3.1) or of the RPA (Section 9.7.2.1) on post-Bonneville survival, compared to average post-Bonneville survival during 1980 to 1999. That is, NMFS considered both the differential survival of transported fish (compared to nontransported fish; D) and the post-Bonneville delayed mortality of nontransported fish (EM hereafter) to be unchanged from the base period to the future under the proposed action and RPA.

In contrast, NMFS considered three alternatives for future post-Bonneville survival after breaching four Snake River dams. In each alternative, the differential post-Bonneville survival of transported fish is eliminated following breaching because NMFS assumes that transportation would cease. The alternatives apply different assumptions regarding the change in delayed mortality of nontransported fish following breaching.

In one alternative, NMFS assumed that delayed mortality of nontransported fish does not change after four Snake River dams are breached. With this alternative, the current estimate of EM is not important, since the calculated change in survival resulting from breaching will be the same whether EM is believed to be 0% or 74%. This alternative corresponds to two of the three PATH extra mortality hypotheses, which ascribe this mortality to causes other than the hydrosystem (Section 6.2.3.3).

In the second alternative, NMFS assumes that average 1980 to 1999 EM is between 71% (when coupled with D = 0.73) and 74% (when coupled with D = 0.63). This represents the PATH estimate of hydrosystem-caused, post-Bonneville mortality, when all extra mortality is believed to be caused by the hydrosystem. The estimate of 71% to 74% delayed mortality of nontransported fish represents the upper end of the range NMFS considered in this analysis (Section 6.2.3.3). This second alternative assumes that approximately half of this mortality is eliminated when four of the eight Snake River dams are breached, which corresponds to PATH's Hydro Hypothesis (Marmorek and Peters 1998; Wilson 2000).

The third alternative is identical to the second, except that it assumes that 100% of the delayed mortality of nontransported fish is eliminated. This assumption was included in the July 27, 2000, Draft Biological Opinion and incorrectly ascribed to the PATH Hydro Hypothesis (Wilson 2000). NMFS retains it because several agencies and organizations that commented on the July 27, 2000, Draft Biological Opinion expressed their opinion that this is the most likely assumption. Because all of these assumptions are essentially beliefs, based on little or no direct evidence, inclusion of the full range of opinions demonstrates the range of possible outcomes after breaching.

Details of the methods and results for each approach are included in Appendix A. A summary follows.

<u>No Change in Delayed Mortality of Nontransported Juveniles After Breaching</u>

NMFS estimated mean juvenile passage survival to Bonneville Dam during the base period, including differential post-Bonneville survival of transported fish (D=0.63 to D=0.73), using the two methods described in Section 6.3.1.3 and applied in Section 9.7.2.1. Although this first approach is not sensitive to assumptions regarding delayed mortality of nontransported fish, the assumption of 70% to 74% EM was applied to facilitate comparison with the other approaches. This resulted in a range of 11% to 13% juvenile survival. Juvenile survival to Bonneville following breaching was estimated at 61.2%, as described in Section 9.7.3.1.3 (Table 9.7-20). When the 70% to 74% delayed mortality assumption is applied to the survival to Bonneville, 16.8% juvenile survival is expected after breaching. The result is a 33% to 39% proportional juvenile survival improvement following breaching.

Adult passage survival during the 1980 to 1999 period was 82.5% (Table 9.7-2). Expected survival following breaching is 85.5% (Section 9.7.3.1.4). The result is a 3.7% proportional adult survival improvement following breaching. When the juvenile and adult survival improvements are combined, the overall effect of breaching four Snake River dams is a 38% to 44% proportional improvement (1.38 to 1.44 times average 1980 to 1999 survival).

This expected improvement is sufficient to result in a positive population growth rate under all assumptions considered in this analysis for six of the seven index stocks (Table 9.7-21). The Imnaha River index stock would continue to decline under the lowest estimate of lambda and would be stable under the highest estimate. Additional survival improvements are not required for any of the index stocks under the most optimistic assumptions. Additional improvements ranging from 5% to 56% would be required with the higher estimate of necessary changes.

Delayed Mortality of Nontransported Juveniles is Reduced by Half After Breaching

All aspects of this approach were identical to the first, except for the level of delayed mortality applied to juvenile survival following breaching. Only half of the delayed mortality estimate was applied in this approach, resulting in 39% juvenile survival following breaching. A 220% to 236% proportional survival improvement is associated with breaching under this alternative. Under this assumption, population growth would be positive for all index stocks, and no additional survival changes would be required (Table 9.7-22).

Delayed Mortality of Nontransported Juveniles is Eliminated After Breaching

All aspects of this approach were identical to the first, except for the level of delayed mortality applied to juvenile survival following breaching. No delayed mortality was applied in this approach, resulting in 61.2% juvenile survival following breaching. A 403% to 427% proportional survival improvement is associated with breaching under this approach. Under this assumption, population growth would be positive for all index stocks, and no additional survival changes would be required (Table 9.7-23).

Comparison to PATH

These results are similar to those of PATH (Marmorek et al. 1998, Peters and Marmorek 2000), with respect to the higher likelihood of meeting approximations of the survival and recovery

Table 9.7-21. Snake River spring/summer chinook estimates of current and expected median annual population growth rate (lambda), expected survival change after breaching four dams, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after breaching four dams. This analysis assumes no change in delayed mortality of nontransported fish after breaching four of eight dams.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.82	0.91	1.38	1.44	0.88	0.99	1.40	1.46	1.07	1.78
Index Stocks:										
Bear Valley/Elk Creeks	1.02	1.03	1.38	1.44	1.09	1.11	0.48	0.73	0.53	0.84
Imnaha River	0.88	0.92	1.38	1.44	0.95	1.00	0.56	1.09	0.84	1.56
Johnson Creek	1.01	1.03	1.38	1.44	1.09	1.12	0.48	0.73	0.47	0.78
Marsh Creek	0.99	1.00	1.38	1.44	1.06	1.08	0.49	0.83	0.65	1.05
Minam River	0.93	1.02	1.38	1.44	1.01	1.11	0.48	1.06	0.56	1.20
Poverty Flats	0.99	1.02	1.38	1.44	1.07	1.12	0.48	0.73	0.49	0.84
Sulphur Creek	1.04	1.05	1.38	1.44	1.11	1.14	0.56	0.99	0.52	0.82
Additional Aggregations:										
Alturas Lake Ck	0.75	0.75	1.38	1.44	0.80	0.81	N/A	N/A	2.57	2.69
American R	0.91	0.91	1.38	1.44	0.98	0.99	N/A	N/A	1.07	1.12
Big Sheep Ck	0.85	0.88	1.38	1.44	0.92	0.93	N/A	N/A	1.24	1.48
Beaver Cr	0.95	0.95	1.38	1.44	1.02	1.03	N/A	N/A	0.86	0.90
Bushy Fork	0.98	0.98	1.38	1.44	1.05	1.06	N/A	N/A	0.76	0.79
Camas Cr	0.92	0.92	1.38	1.44	0.99	1.00	N/A	N/A	1.00	1.04
Cape Horn Cr	1.05	1.05	1.38	1.44	1.13	1.14	N/A	N/A	0.55	0.58
Catherine Ck	0.78	0.85	1.38	1.44	0.84	0.85	N/A	N/A	1.44	2.17
Catherine Ck N Fk	0.92	0.92	1.38	1.44	0.99	1.00	N/A	N/A	1.00	1.05
Catherine Ck S Fk	0.80	0.80	1.38	1.44	0.85	0.86	N/A	N/A	1.92	2.01
Crooked Fork	1.00	1.00	1.38	1.44	1.07	1.08	N/A	N/A	0.70	0.73
Grande Ronde R	0.77	0.84	1.38	1.44	0.83	0.84	N/A	N/A	1.52	2.28
Knapp Cr	0.89	0.89	1.38	1.44	0.96	0.97	N/A	N/A	1.17	1.22
Lake Cr	1.06	1.06	1.38	1.44	1.14	1.15	N/A	N/A	0.54	0.56
Lemhi R	0.98	0.98	1.38	1.44	1.05	1.06	N/A	N/A	0.77	0.81
Lookingglass Ck	0.72	0.79	1.38	1.44	0.78	0.79	N/A	N/A	1.93	3.05
Loon Ck	1.00	1.00	1.38	1.44	1.08	1.09	N/A	N/A	0.68	0.71
Lostine Ck	0.87	0.90	1.38	1.44	0.94	0.94	N/A	N/A	1.10	1.35
Lower Salmon R	0.92	0.92	1.38	1.44	0.98	1.00	N/A	N/A	1.02	1.07
Lower Valley Ck	0.92	0.92	1.38	1.44	0.99	1.00	N/A	N/A	0.99	1.03
Moose Ck	0.94	0.94	1.38	1.44	1.01	1.02	N/A	N/A	0.90	0.94
Newsome Ck	1.03	1.03	1.38	1.44	1.10	1.12	N/A	N/A	0.61	0.64
Red R	0.91	0.91	1.38	1.44	0.98	0.99	N/A	N/A	1.06	1.11
Salmon R E Fk	0.94	0.94	1.38	1.44	1.01	1.02	N/A	N/A	0.92	0.96
Salmon R S Fk	1.06	1.06	1.38	1.44	1.14	1.15	N/A	N/A	0.54	0.56
Secesh R	0.98	0.98	1.38	1.44	1.05	1.06	N/A	N/A	0.77	0.81
Selway R	0.91	0.91	1.38	1.44	0.98	0.99	N/A	N/A	1.04	1.09
Sheep Cr	0.80	0.80	1.38	1.44	0.86	0.87	N/A	N/A	1.89	1.97
Upper Big Ck	0.97	0.97	1.38	1.44	1.04	1.05	N/A	N/A	0.80	0.84
Upper Salmon R	0.90	0.90	1.38	1.44	0.97	0.98	N/A	N/A	1.09	1.14
Upper Valley Ck	1.03	1.03	1.38	1.44	1.11	1.12	N/A	N/A	0.60	0.63
Wallowa Ck	0.86	0.86	1.38	1.44	0.92	0.93	N/A	N/A	1.36	1.42
Wenaha R	0.84	0.90	1.38	1.44	0.90	0.91	N/A	N/A	1.09	1.56
Whitecap Ck	0.90	0.90	1.38	1.44	0.97	0.98	N/A	N/A	1.09	1.14
Yankee Fork	0.88	0.88	1.38	1.44	0.95	0.96	N/A	N/A	1.21	1.27
Yankee West Fk	0.99	0.99	1.38	1.44	1.06	1.07	N/A	N/A	0.73	0.76

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically, except for the Imnaha (50% as effective). For index stocks, it also includes preliminary 2000 and projected 2001 returns in time series used to estimate lambda.
[3] Low represents estimation of juvenile survival improvement based on a comparison of PATH retrospective and prospective (A2) results.
[4] High represents estimation of juvenile survival improvement based on a combination of PATH and SIMPAS results.
[5] Low represents the low 1980-to-1999 lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-1999 lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A, including preliminary 2000 and projected 2001 returns for index stocks) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A, including only final returns through 1999) divided by the low estimate.

Table 9.7-22. Snake River spring/summer chinook estimates of current and expected median annual population growth rate (lambda), expected survival change after breaching four dams, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after breaching four dams. This analysis assumes high delayed mortality of nontransported fish in the base period, with half of it removed after breaching four of eight dams.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.82	0.91	3.20	3.36	1.05	1.18	0.60	0.63	0.46	0.77
Index Stocks:										
Bear Valley/Elk Creeks	1.02	1.03	3.20	3.36	1.30	1.33	0.09	0.31	0.10	0.36
Imnaha River	0.88	0.92	3.20	3.36	1.14	1.21	0.10	0.47	0.15	0.67
Johnson Creek	1.01	1.03	3.20	3.36	1.32	1.37	0.09	0.31	0.09	0.34
Marsh Creek	0.99	1.00	3.20	3.36	1.27	1.30	0.09	0.36	0.12	0.45
Minam River	0.93	1.02	3.20	3.36	1.23	1.36	0.09	0.46	0.10	0.52
Poverty Flats	0.99	1.02	3.20	3.36	1.31	1.36	0.09	0.31	0.09	0.36
Sulphur Creek	1.04	1.05	3.20	3.36	1.34	1.37	0.10	0.43	0.10	0.35
Additional Aggregations:										
Alturas Lake Ck	0.75	0.75	3.20	3.36	0.97	0.98	N/A	N/A	1.11	1.16
American R	0.91	0.91	3.20	3.36	1.18	1.19	N/A	N/A	0.46	0.48
Big Sheep Ck	0.85	0.88	3.20	3.36	1.11	1.12	N/A	N/A	0.53	0.64
Beaver Cr	0.95	0.95	3.20	3.36	1.24	1.25	N/A	N/A	0.37	0.39
Bushy Fork	0.98	0.98	3.20	3.36	1.27	1.29	N/A	N/A	0.33	0.34
Camas Cr	0.92	0.92	3.20	3.36	1.20	1.21	N/A	N/A	0.43	0.45
Cape Horn Cr	1.05	1.05	3.20	3.36	1.37	1.38	N/A	N/A	0.24	0.25
Catherine Ck	0.78	0.85	3.20	3.36	1.02	1.03	N/A	N/A	0.62	0.93
Catherine Ck N Fk	0.92	0.92	3.20	3.36	1.20	1.21	N/A	N/A	0.43	0.45
Catherine Ck S Fk	0.80	0.80	3.20	3.36	1.03	1.04	N/A	N/A	0.83	0.87
Crooked Fork	1.00	1.00	3.20	3.36	1.30	1.31	N/A	N/A	0.30	0.31
Grande Ronde R	0.77	0.84	3.20	3.36	1.00	1.01	N/A	N/A	0.65	0.98
Knapp Cr	0.89	0.89	3.20	3.36	1.16	1.17	N/A	N/A	0.50	0.53
Lake Cr	1.06	1.06	3.20	3.36	1.37	1.39	N/A	N/A	0.23	0.24
Lemhi R	0.98	0.98	3.20	3.36	1.27	1.28	N/A	N/A	0.33	0.35
Lookingglass Ck	0.72	0.79	3.20	3.36	0.94	0.95	N/A	N/A	0.83	1.31
Loon Ck	1.00	1.00	3.20	3.36	1.30	1.32	N/A	N/A	0.29	0.31
Lostine Ck	0.87	0.90	3.20	3.36	1.13	1.14	N/A	N/A	0.47	0.58
Lower Salmon R	0.92	0.92	3.20	3.36	1.19	1.20	N/A	N/A	0.44	0.46
Lower Valley Ck	0.92	0.92	3.20	3.36	1.20	1.21	N/A	N/A	0.42	0.44
Moose Ck	0.94	0.94	3.20	3.36	1.23	1.24	N/A	N/A	0.39	0.40
Newsome Ck	1.03	1.03	3.20	3.36	1.33	1.35	N/A	N/A	0.26	0.28
Red R	0.91	0.91	3.20	3.36	1.18	1.19	N/A	N/A	0.46	0.48
Salmon R E Fk	0.94	0.94	3.20	3.36	1.22	1.23	N/A	N/A	0.39	0.41
Salmon R S Fk	1.06	1.06	3.20	3.36	1.37	1.39	N/A	N/A	0.23	0.24
Secesh R	0.98	0.98	3.20	3.36	1.27	1.28	N/A	N/A	0.33	0.35
Selway R	0.91	0.91	3.20	3.36	1.19	1.20	N/A	N/A	0.45	0.47
Sheep Cr	0.80	0.80	3.20	3.36	1.04	1.05	N/A	N/A	0.81	0.85
Upper Big Ck	0.97	0.97	3.20	3.36	1.26	1.27	N/A	N/A	0.34	0.36
Upper Salmon R	0.90	0.90	3.20	3.36	1.17	1.19	N/A	N/A	0.47	0.49
Upper Valley Ck	1.03	1.03	3.20	3.36	1.34	1.35	N/A	N/A	0.26	0.27
Wallowa Ck	0.86	0.86	3.20	3.36	1.12	1.13	N/A	N/A	0.58	0.61
Wenaha R	0.84	0.90	3.20	3.36	1.09	1.10	N/A	N/A	0.47	0.67
Whitecap Ck	0.90	0.90	3.20	3.36	1.17	1.18	N/A	N/A	0.47	0.49
Yankee Fork	0.88	0.88	3.20	3.36	1.15	1.16	N/A	N/A	0.52	0.54
Yankee West Fk	0.99	0.99	3.20	3.36	1.28	1.30	N/A	N/A	0.31	0.33

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically, except for the Imnaha (50% as effective). For index stocks, it also includes preliminary 2000 and projected 2001 returns in time series used to estimate lambda.
[3] Low represents estimation of juvenile survival improvement based on a comparison of PATH retrospective and prospective (A2) results.
[4] High represents estimation of juvenile survival improvement based on a combination of PATH and SIMPAS results.
[5] Low represents the low 1980-to-1999 lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
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[7] Low represents the lowest estimate of needed survival improvement (Appendix A, including preliminary 2000 and projected 2001 returns for index stocks) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A, including only final returns through 1999) divided by the low estimate of the expected survival improvement.

Table 9.7-23. Snake River spring/summer chinook estimates of current and expected median annual population growth rate (lambda), expected survival change after breaching four dams, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after breaching four dams. This analysis assumes high delayed mortality of nontransported fish in the base period, with all of it removed after breaching four of eight dams.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
ESU Aggregate	0.82	0.91	5.03	5.27	1.15	1.30	0.38	0.40	0.29	0.49
Index Stocks:										
Bear Valley/Elk Creeks	1.02	1.03	5.03	5.27	1.43	1.46	0.04	0.20	0.04	0.23
Imnaha River	0.88	0.92	5.03	5.27	1.26	1.34	0.04	0.30	0.06	0.43
Johnson Creek	1.01	1.03	5.03	5.27	1.46	1.51	0.04	0.20	0.03	0.21
Marsh Creek	0.99	1.00	5.03	5.27	1.39	1.43	0.04	0.23	0.05	0.29
Minam River	0.93	1.02	5.03	5.27	1.37	1.51	0.04	0.29	0.04	0.33
Poverty Flats	0.99	1.02	5.03	5.27	1.45	1.52	0.04	0.20	0.04	0.23
Sulphur Creek	1.04	1.05	5.03	5.27	1.48	1.51	0.04	0.27	0.04	0.23
Additional Aggregations:										
Alturas Lake Ck	0.75	0.75	5.03	5.27	1.07	1.08	N/A	N/A	0.70	0.74
American R	0.91	0.91	5.03	5.27	1.30	1.32	N/A	N/A	0.29	0.31
Big Sheep Ck	0.85	0.88	5.03	5.27	1.22	1.24	N/A	N/A	0.34	0.41
Beaver Cr	0.95	0.95	5.03	5.27	1.37	1.38	N/A	N/A	0.24	0.25
Bushy Fork	0.98	0.98	5.03	5.27	1.41	1.42	N/A	N/A	0.21	0.22
Camas Cr	0.92	0.92	5.03	5.27	1.32	1.34	N/A	N/A	0.27	0.29
Cape Horn Cr	1.05	1.05	5.03	5.27	1.51	1.53	N/A	N/A	0.15	0.16
Catherine Ck	0.78	0.85	5.03	5.27	1.12	1.14	N/A	N/A	0.40	0.60
Catherine Ck N Fk	0.92	0.92	5.03	5.27	1.32	1.34	N/A	N/A	0.27	0.29
Catherine Ck S Fk	0.80	0.80	5.03	5.27	1.14	1.15	N/A	N/A	0.53	0.55
Crooked Fork	1.00	1.00	5.03	5.27	1.43	1.45	N/A	N/A	0.19	0.20
Grande Ronde R	0.77	0.84	5.03	5.27	1.11	1.12	N/A	N/A	0.42	0.62
Knapp Cr	0.89	0.89	5.03	5.27	1.28	1.29	N/A	N/A	0.32	0.33
Lake Cr	1.06	1.06	5.03	5.27	1.52	1.54	N/A	N/A	0.15	0.15
Lemhi R	0.98	0.98	5.03	5.27	1.40	1.42	N/A	N/A	0.21	0.22
Lookingglass Ck	0.72	0.79	5.03	5.27	1.04	1.05	N/A	N/A	0.53	0.84
Loon Ck	1.00	1.00	5.03	5.27	1.44	1.46	N/A	N/A	0.19	0.20
Lostine Ck	0.87	0.90	5.03	5.27	1.25	1.26	N/A	N/A	0.30	0.37
Lower Salmon R	0.92	0.92	5.03	5.27	1.32	1.33	N/A	N/A	0.28	0.29
Lower Valley Ck	0.92	0.92	5.03	5.27	1.33	1.34	N/A	N/A	0.27	0.28
Moose Ck	0.94	0.94	5.03	5.27	1.36	1.37	N/A	N/A	0.25	0.26
Newsome Ck	1.03	1.03	5.03	5.27	1.47	1.49	N/A	N/A	0.17	0.18
Red R	0.91	0.91	5.03	5.27	1.31	1.32	N/A	N/A	0.29	0.30
Salmon R E Fk	0.94	0.94	5.03	5.27	1.35	1.36	N/A	N/A	0.25	0.26
Salmon R S Fk	1.06	1.06	5.03	5.27	1.52	1.54	N/A	N/A	0.15	0.15
Secesh R	0.98	0.98	5.03	5.27	1.40	1.42	N/A	N/A	0.21	0.22
Selway R	0.91	0.91	5.03	5.27	1.31	1.33	N/A	N/A	0.28	0.30
Sheep Cr	0.80	0.80	5.03	5.27	1.15	1.16	N/A	N/A	0.52	0.54
Upper Big Ck	0.97	0.97	5.03	5.27	1.39	1.40	N/A	N/A	0.22	0.23
Upper Salmon R	0.90	0.90	5.03	5.27	1.30	1.31	N/A	N/A	0.30	0.31
Upper Valley Ck	1.03	1.03	5.03	5.27	1.48	1.50	N/A	N/A	0.16	0.17
Wallowa Ck	0.86	0.86	5.03	5.27	1.23	1.25	N/A	N/A	0.37	0.39
Wenaha R	0.84	0.90	5.03	5.27	1.21	1.22	N/A	N/A	0.30	0.43
Whitecap Ck	0.90	0.90	5.03	5.27	1.30	1.31	N/A	N/A	0.30	0.31
Yankee Fork	0.88	0.88	5.03	5.27	1.27	1.28	N/A	N/A	0.33	0.35
Yankee West Fk	0.99	0.99	5.03	5.27	1.42	1.43	N/A	N/A	0.20	0.21

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically, except for the Imnaha (50% as effective). For index stocks, it also includes preliminary 2000 and projected 2001 returns in time series used to estimate lambda.
[3] Low represents estimation of juvenile survival improvement based on a comparison of PATH retrospective and prospective (A2) results.
[4] High represents estimation of juvenile survival improvement based on a combination of PATH and SIMPAS results.
[5] Low represents the low 1980-to-1999 lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-1999 lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A, including preliminary 2000 and projected 2001 returns for index stocks) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A, including only final returns through 1999) divided by the low estimate of the expected survival improvement.

indicator metrics with breaching than with a modeling scenario approximating the RPA. PATH results also indicated that the degree of difference between the actions depends largely on assumptions regarding delayed mortality of both transported and nontransported fish. PATH analyses differed from the analysis described above in at least one significant way. PATH considered a wide range of differential delayed mortality estimates, rather than the D = 0.63 to D = 0.73 range included in the analyses described above. Half of the PATH analyses included estimates of D that were considerably lower (approximately D = 0.35), which means that for these PATH analyses survival following breaching would increase substantially more than the amount estimated above, simply as a result of eliminating transportation. As described in Section 6.2.3.3, NMFS finds that available empirical information does not support such low estimates of differential post-Bonneville survival. As a result of this and other factors, PATH concluded that the average results for all assumptions considered by PATH indicated that breaching four Snake River dams would easily meet survival and recovery indicator metrics. NMFS results indicate that the ability to meet survival and recovery indicator metrics depends largely on assumptions regarding the degree to which delayed mortality of nontransported fish is reduced—assumptions that cannot be validated with available information.

9.7.3.2.2 Snake River Fall Chinook Salmon

NMFS evaluated the same aggregate population and used the same general approach as that described in Section 9.7.2.2. The necessary improvements in survival from average base period conditions were also as described in Section 9.7.2.2.

A key uncertainty associated with dam breaching is the effect that it will have on survival below Bonneville Dam. NMFS evaluated the same three assumptions described in Section 9.7.3.2.1 regarding the effect of breaching on delayed mortality of nontransported smolts. Although the rationale and conflicting opinions on potential effects have mainly been developed for SR spring/summer chinook salmon, most can also be applied to SR fall chinook salmon.

In one alternative, NMFS assumed that delayed mortality of nontransported fish does not change after four Snake River dams are breached. With this alternative, the current estimate of EM is not important, since the calculated change in survival resulting from breaching will be the same whether EM is believed to be 0% or 19%. This alternative corresponds to two of the three PATH extra mortality hypotheses for SR spring/summer chinook salmon, which ascribe this mortality to causes other than the hydrosystem (Section 6.2.3.3).

In the second alternative, NMFS assumes that average base period EM is 19% (Section 6.2.3.3). This represents the mean PATH estimate of hydrosystem-caused, post-Bonneville mortality, when D=0.24, and all extra mortality is believed to be caused by the hydrosystem. The estimate of 19% delayed mortality of nontransported fish represents the upper end of the range NMFS considered in this analysis (Section 6.2.3.3). This second alternative assumes that approximately half of this mortality is eliminated when four of the eight Snake River dams are breached, which corresponds to PATH's SR spring/summer chinook Hydro Hypothesis (Marmorek and Peters 1998, Wilson 2000).

The third alternative is identical to the second, except that it assumes that 100% of the delayed mortality of nontransported fish is eliminated. This assumption was included in the July 27, 2000, Draft Biological Opinion and incorrectly ascribed to the PATH Hydro Hypothesis (Wilson 2000). NMFS retains it because several agencies and organizations that commented on the July 27, 2000, Draft Biological Opinion expressed their opinion that this is the most likely assumption. Because all of these assumptions are essentially beliefs, based on little or no direct evidence, inclusion of the full range of opinions demonstrates the range of possible outcomes after breaching.

Details of the methods and results for each approach are included in Appendix A. A summary follows.

<u>No Change in Delayed Mortality of Nontransported Juveniles After Breaching</u>

NMFS estimated mean juvenile passage survival to Bonneville Dam during the base period, including differential post-Bonneville survival of transported fish (D = 0.24), using the method described in Section 6.3.2.3 and applied in Section 9.7.2.3. NMFS has not estimated differential post-Bonneville survival of SR fall chinook and the estimate of 0.24 represents one of the alternative PATH estimates that NMFS considers most consistent with the limited empirical information (Section 6.2.3.3). It is used in the absence of an alternative empirically based estimate. Although this first approach is not sensitive to assumptions regarding delayed mortality of nontransported fish, the assumption of 19% EM was applied to facilitate comparison with the other approaches. This resulted in 14% juvenile survival. Juvenile survival to Bonneville following dam breaching was estimated at 23.8% to 34.0%, as described in Section 9.7.3.1.3 (Table 9.7-20). When the 19% delayed mortality assumption is applied to the survival to Bonneville, 19% to 28% juvenile survival is expected after breaching. The result is a 36% to 95% proportional juvenile survival improvement following breaching.

Adult passage survival during the base period was 71% (Table 9.7-2). Expected survival following breaching is 74% (Section 9.7.3.1.4). The result is a 4.2% proportional adult survival improvement following breaching. When the juvenile and adult survival improvements are combined, the overall effect of breaching four Snake River dams is a 64% to 185% proportional improvement (1.64 to 2.85 times average base period survival).

This expected improvement is sufficient to result in a positive population growth rate under the most optimistic assumptions, but the population would continue to decline under the lowest estimate of lambda (Table 9.7-24). No additional survival improvements are required under the most optimistic assumptions. An additional 32% improvement (1.32 times average 1980 to 1996 survival) would be required with the higher estimate of necessary changes.

Table 9.7-24. Snake River fall chinook estimates of current and expected median annual population growth rate (lambda), expected survival change from breaching four dams, and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after breaching four dams.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
No Change In Nontransport Delayed Mortality:										
Aggregate SR Fall Chinook	0.87	0.92	1.63	2.87	0.98	1.18	0.43	0.86	0.60	1.32
Nontransport Delayed Mortality Reduced By Half:										
Aggregate SR Fall Chinook	0.87	0.92	1.82	3.20	1.01	1.22	0.38	0.77	0.54	1.18
Nontransport Delayed Mortality Completely Eliminated:										
Aggregate SR Fall Chinook	0.87	0.92	2.01	3.54	1.03	1.25	0.35	0.70	0.49	1.07

[1] Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
[2] High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
[3] Low represents estimation of juvenile survival improvement based on PATH retrospective and prospective (A2) results and change in harvest rate based on PATH.
[4] High represents estimation of juvenile survival improvement based on a combination of PATH and SIMPAS and harvest rate change based on PSC.
[5] Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
[6] High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
[7] Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
[8] High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.

Delayed Mortality of Nontransported Juveniles Is Reduced by Half After Breaching

All aspects of this approach were identical to the first, except for the level of delayed mortality applied to juvenile survival following breaching. Only half of the delayed mortality estimate was applied in this approach, resulting in 21.5% to 30.8% juvenile survival following breaching. A 282% to 420% proportional survival improvement is associated with breaching under this alternative. Under this assumption, population growth would be positive, and no additional survival changes would be required under the most optimistic assumptions. However, an additional 18% survival improvement (1.18 times average 1980 to 1996 survival) would be necessary under the high estimate of necessary survival changes.

Delayed Mortality of Nontransported Juveniles Is Eliminated After Breaching

All aspects of this approach were identical to the first, except for the level of delayed mortality applied to juvenile survival following breaching. No delayed mortality was applied in this approach, resulting in 23.8% to 34% juvenile survival following breaching. A 301% to 454% proportional survival improvement is associated with breaching under this approach. Under this assumption, population growth would be positive for all index stocks, and no additional survival changes would be required under the most optimistic assumptions. However, an additional 7% survival improvement (1.07 times average 1980 to 1996 survival) would be necessary under the high estimate of necessary survival changes.

Comparison to PATH

These results are similar to those of PATH (Peters et al. 1999), with respect to the higher likelihood of meeting approximations of the survival and recovery indicator metrics with breaching than with a modeling scenario approximating the RPA, when similar D assumptions are applied. PATH results also indicated that the degree of difference between the actions depends largely on assumptions regarding delayed mortality of both transported and nontransported fish. Under PATH's average assumptions, however, breaching met approximations of the 1995 FCRPS Biological Opinion's jeopardy standards, without the need for any additional survival improvements. NMFS' results indicate that this is likely to happen only if delayed mortality of nontransported fish is currently high and if breaching four dams significantly reduces that delayed mortality.

Both PATH and NMFS' analysis may be somewhat pessimistic regarding the effects of breaching, since the potential additional spawning areas created by breaching had little analytical effect in PATH's analysis and were not analytically considered in this analysis. PATH assumed that most of the newly created habitat would be inferior to that currently available, so did not model a change in carrying capacity until estimated capacity of the currently available habitat was exceeded. This meant that additional spawning habitat did not improve survival until the population was near the recovery level. One organization (Save Our Wild Salmon) commented that NMFS needed to consider the benefits of additional spawning areas in the analysis. This is considered qualitatively in Section 9.7.3.1.2.

9.7.3.2.3 Snake River Steelhead

NMFS evaluated the same spawning aggregations and used the same general approach as that described in Section 9.7.2.6. The necessary improvements in survival from average base period conditions were also as described in Section 9.7.2.6.

A key uncertainty associated with dam breaching is the effect that it will have on survival below Bonneville Dam. NMFS evaluated the same three assumptions described in Section 9.7.3.2.1 regarding the effect of breaching on delayed mortality of nontransported smolts. Although the rationale and conflicting opinions on potential effects have mainly been developed for SR spring/summer chinook salmon, most can also be applied to SR steelhead.

In one alternative, NMFS assumed that delayed mortality of nontransported fish does not change after four Snake River dams are breached. With this alternative, the current estimate of EM is not important, since the calculated change in survival resulting from breaching will be the same whether EM is believed to be 0% or 74%. This alternative corresponds to two of the three PATH extra mortality hypotheses for SR spring/summer chinook salmon, which ascribe this mortality to causes other than the hydrosystem (Section 6.2.3.3).

In the second alternative, NMFS assumes that average base period EM is equivalent to that described for SR spring/summer chinook in Section 9.7.3.2.1. This second alternative assumes that approximately half of this mortality is eliminated when four of the eight Snake River dams are breached, which corresponds to PATH's SR spring/summer chinook Hydro Hypothesis (Marmorek and Peters 1998, Wilson 2000).

The third alternative is identical to the second, except that it assumes that 100% of the delayed mortality of nontransported fish is eliminated. This assumption was included in the July 27, 2000, Draft Biological Opinion and incorrectly ascribed to the PATH Hydro Hypothesis (Wilson 2000). NMFS retains it because several agencies and organizations that commented on the July 27, 2000, Draft Biological Opinion expressed their opinion that this is the most likely assumption. Because all of these assumptions are essentially beliefs, based on little or no direct evidence, inclusion of the full range of opinions demonstrates the range of possible outcomes after breaching.

Details of the methods and results for each approach are included in Appendix A. A summary follows.

<u>No Change in Delayed Mortality of Nontransported Juveniles After Breaching</u>

NMFS assumed that the change from juvenile passage survival to Bonneville Dam during the base period, including differential post-Bonneville survival of transported fish (D=0.52 to D = 0.58), to juvenile survival associated with current operations was the same as that which was estimated for SR spring/summer chinook (Section 6.3.6). NMFS estimated this change as a 24% to 32% proportional improvement. NMFS also estimated changes in harvest rates (Section 6.3.6).

In addition, breaching represents a further survival change from current conditions. Although this first approach is not sensitive to assumptions regarding delayed mortality of nontransported fish, the average SR spring/summer chinook assumption of 73% EM was applied to the estimate of current juvenile survival to facilitate comparison with the other approaches. This resulted in 14% current juvenile survival. Juvenile survival to Bonneville following dam breaching was estimated at 63%, as described in Section 9.7.3.1.3 (Table 9.7-20). When the 73% delayed mortality assumption is applied to the survival to Bonneville, 17.3% juvenile survival is expected after breaching. The result is a 24.5% proportional juvenile survival improvement from current conditions following breaching.

Adult passage survival during the base period was 77.3% (Table 9.7-2). Expected survival following breaching is 80.3% (Section 9.7.3.1.4). The result is a 3.9% proportional adult survival improvement following breaching. When the change from average base period juvenile survival to current juvenile survival, the change from current juvenile survival to juvenile survival after breaching, harvest reductions, and the adult survival improvement are combined, the overall effect of breaching four Snake River dams is a 65% to 77% proportional improvement for A-run steelhead and a 79% to 92% improvement for B-run steelhead.

This expected improvement is not sufficient to produce a positive population growth rate, and additional survival improvements ranging from 25% to 278% (1.25 to 3.78 times average base period survival) would still be necessary to meet survival and recovery indicator criteria (Table 9.7-25).

Delayed Mortality of Nontransported Juveniles Is Reduced by Half After Breaching

All aspects of this approach were identical to the first, except for the level of delayed mortality applied to juvenile survival following breaching. Only half of the delayed mortality estimate was applied in this approach, resulting in 40.1% juvenile survival following breaching. A 285% to 311% proportional survival improvement is associated with breaching under this alternative. Under this assumption, the highest estimates of population growth would be positive, and the lowest would remain negative (Table 9.7-25). No additional survival changes would be required under the most optimistic assumptions. However, an additional 18% to 63% survival improvement (1.18 to 1.63 times average base period survival) would be necessary under the high estimate of necessary survival changes.

Delayed Mortality of Nontransported Juveniles Is Eliminated After Breaching

All aspects of this approach were identical to the first, except for the level of delayed mortality applied to juvenile survival following breaching. No delayed mortality was applied in this approach, resulting in 63% juvenile survival following breaching. A 503% to 544% proportional survival improvement is associated with breaching under this approach. Under this assumption, population growth would be positive except under the low assumptions for B-run steelhead. No additional survival changes would be required for A-run steelhead under all assumptions or for B-run steelhead under the most optimistic assumptions (Table 9.7-25). However, an additional 4% survival improvement (1.04 times average base period survival) would be necessary for B-run steelhead under the high estimate of necessary survival changes.

9.7.3.2.4 Snake River Sockeye Salmon

Because the abundance of SR sockeye salmon is extremely low, the risk of extinction cannot be calculated using the methods that NMFS employs in this biological opinion. However, current risk is undoubtedly very high.

Table 9.7-25. Snake River steelhead estimates of current and expected median annual population growth rate (lambda), expected survival change from breaching four dams and additional per-generation survival improvements needed to achieve indicators of NMFS' jeopardy standard after breaching four Snake River dams.

Spawning Aggregation	1980-Current Lambda		Expected Survival Change		Expected Lambda		Additional Change In Survival Needed to Achieve: 5% Extinction Risk In 100 Years		Additional Change In Survival Needed to Achieve: 50% Recovery In 48 Years or Lambda = 1.0	
	Low[1]	High[2]	Low[3]	High[4]	Low[5]	High[6]	Low[7]	High[8]	Low[7]	High[8]
No Change In Nontransport Delayed Mortality:										
ESU Aggregate	0.72	0.83	1.72	1.84	0.80	0.94	0.81	1.69	1.38	3.14
A-Run Aggregate	0.74	0.85	1.65	1.77	0.82	0.96	0.74	1.52	1.25	2.74
A-Run Pseudopopulation[9]	0.74	0.85	1.65	1.77	0.82	0.96	0.83	1.68	1.25	2.74
B-Run Aggregate	0.74	0.84	1.79	1.92	0.81	0.92	1.03	2.19	1.68	3.78
B-Run Pseudopopulation[10]	0.74	0.84	1.79	1.92	0.81	0.92	1.09	2.31	1.68	3.78
Nontransport Delayed Mortality Reduced By Half:										
ESU Aggregate	0.72	0.83	4.01	4.28	0.94	1.11	0.35	0.73	0.59	1.35
A-Run Aggregate	0.74	0.85	3.84	4.11	0.97	1.13	0.32	0.65	0.54	1.18
A-Run Pseudopopulation[9]	0.74	0.85	3.84	4.11	0.97	1.13	0.36	0.72	0.54	1.18
B-Run Aggregate	0.74	0.84	4.17	4.46	0.93	1.05	0.44	0.94	0.72	1.63
B-Run Pseudopopulation[10]	0.74	0.84	4.17	4.46	0.93	1.05	0.47	0.99	0.72	1.63
Nontransport Delayed Mortality Completely Eliminated:										
ESU Aggregate	0.72	0.83	6.29	6.72	1.03	1.21	0.22	0.46	0.38	0.86
A-Run Aggregate	0.74	0.85	6.03	6.44	1.06	1.24	0.20	0.42	0.34	0.75
A-Run Pseudopopulation[9]	0.74	0.85	6.03	6.44	1.06	1.24	0.23	0.46	0.34	0.75
B-Run Aggregate	0.74	0.84	6.55	6.99	0.99	1.13	0.28	0.60	0.46	1.04
B-Run Pseudopopulation[10]	0.74	0.84	6.55	6.99	0.99	1.13	0.30	0.63	0.46	1.04

1 Low represents assumption that hatchery-origin natural spawners have been 80% as effective as wild spawners historically.
2 High represents assumption that hatchery-origin natural spawners have been 20% as effective as wild spawners historically.
3 Low represents SR spring/summer chinook Low estimate.
4 High represents SR spring/summer chinook High estimate.
5 Low represents the low 1980-to-current lambda estimate multiplied by the low survival improvement estimate, raised to the power of 1/mean generation time.
6 High represents the high 1980-to-current lambda estimate multiplied by the high survival improvement estimate, raised to the power of 1/mean generation time.
7 Low represents the lowest estimate of needed survival improvement (Appendix A) divided by the high estimate of the expected survival improvement.
8 High represents the highest estimate of needed survival improvement (Appendix A) divided by the low estimate of the expected survival improvement.
9 Pseudopopulation is 10% of A-run aggregate abundance.
10 Pseudopopulation is 33% of B-run aggregate abundance.

Due to the extreme low abundance of SR sockeye salmon in recent years, this ESU has not been used in passage survival studies. Therefore, NMFS has not estimated natural system survival or total system survival associated with breaching four Snake River dams for this ESU. Assuming that juvenile mortality in the action area is similar to that of other yearling migrants, dam breaching has the potential to increase action-area survival substantially if delayed mortality is currently high and if it is largely eliminated by breaching four of the eight FCRPS dams that sockeye must pass. Because the extinction risk for SR sockeye is most likely greater than that for SR steelhead and SR spring/summer chinook, additional survival improvements may also be needed for SR sockeye. If, on the other hand, delayed mortality is currently low or if there is no change in delayed mortality following breaching, dam breaching will result in action-area survival similar to the RPA. In this case, substantial survival improvements in addition to breaching would also be needed.

Because a quantitative analysis was not possible for this species, it is difficult to place the effects of the hydrosystem following a four-dam breach in the context of other factors influencing this ESU's survival and recovery. Other factors also affect elements of critical habitat and thus contribute to this ESU's high risk of extinction (summarized in Section 4.1 and Appendix A) and have been discussed in previous sections.

9.7.3.2.5 Eight Other ESUs

Because eight of the ESUs addressed in this biological opinion are distributed downstream of the Snake River dams, the effect of dam breaching would be identical to that of the RPA for UCR spring chinook, LCR chinook, UWR chinook, UCR steelhead, MCR steelhead, LCR steelhead, UWR steelhead, and CR chum salmon. One possible exception may be possible water quality changes, which could affect downstream stocks in an unquantifiable manner.

9.7.3.2.6 Summary—Effects of Snake River Four-Dam Breach on Biological Requirements Over Full Life Cycle

Breaching four Snake River dams is expected to have little or no effect on eight of the ESUs considered in this biological opinion because they do not pass through the lower Snake River. For these ESUs, the effect of dam breaching is identical, or nearly so, to that of the RPA. For the four Snake River ESUs that would be affected by dam breaching, the effect of this action, relative to the RPA, is determined almost entirely by delayed mortality assumptions, as described in previous sections.

The primary biological issue regarding breaching is the extent to which breaching four Snake River dams is likely to modify post-Bonneville survival of Snake River ESUs. If post-Bonneville survival improves significantly after breaching, this option is biologically superior to the RPA and has the potential to recover the four Snake River ESUs, even without additional offsite mitigation (Table 9.7-26). However, if the principal effect is constrained to the area that would be modified above Bonneville Dam, breaching represents only a marginal improvement

Table 9.7-26. Estimated percentage of additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after breaching four Snake River dams. Low and High estimates are based on a range of assumptions, as described in the text. Three assumptions regarding the effect of breaching on delayed mortality of nontransported fish are shown to demonstrate the influence of this assumption on results. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the RPA, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

Spawning Aggregation	Needed Survival Change After Implementing Hydrosystem Component of RPA (From Table 9.7-17)		Needed Survival Change if no Change in Non-Transport Delayed Mortality After Breaching (Whether Current Level is High or Low)		Needed Survival Change if Non-Transport Delayed Mortality is Currently High and is Reduced by Half After Breaching		Needed Survival Change if Non-Transport Delayed Mortality is Currently High and is Completely Eliminated After Breaching	
	Low	High	Low	High	Low	High	Low	High
Snake River Spring/Summer Chinook								
Aggregate ESU	46	89	40	78	0	0	0	0
Bear Valley/Elk Creeks	0	0	0	0	0	0	0	0
Imnaha River	26	66	0	56	0	0	0	0
Johnson Creek	0	0	0	0	0	0	0	0
Marsh Creek	0	12	0	5	0	0	0	0
Minam River	0	28	0	20	0	0	0	0
Poverty Flats	0	0	0	0	0	0	0	0
Sulphur Creek	0	5	0	0	0	0	0	0
Alturas Lake Ck	168	186	157	169	11	16	0	0
American R	11	19	7	12	0	0	0	0
Big Sheep Ck	29	58	24	48	0	0	0	0
Beaver Cr	0	0	0	0	0	0	0	0
Bushy Fork	0	0	0	0	0	0	0	0
Camas Cr	4	11	0	4	0	0	0	0
Cape Horn Cr	0	0	0	0	0	0	0	0
Catherine Ck	50	131	44	117	0	0	0	0
Catherine Ck N Fk	4	12	0	5	0	0	0	0
Catherine Ck S Fk	101	114	92	101	0	0	0	0
Crooked Fork	0	0	0	0	0	0	0	0
Grande Ronde R	58	142	52	128	0	0	0	0
Knapp Cr	22	30	17	22	0	0	0	0
Lake Cr	0	0	0	0	0	0	0	0
Lemhi R	0	0	0	0	0	0	0	0
Lookingglass Ck	102	225	93	205	0	31	0	0
Loon Ck	0	0	0	0	0	0	0	0
Lostine Ck	15	44	10	35	0	0	0	0
Lower Salmon R	7	14	2	7	0	0	0	0
Lower Valley Ck	3	10	0	3	0	0	0	0
Moose Ck	0	0	0	0	0	0	0	0
Newsome Ck	0	0	0	0	0	0	0	0

Table 9.7-26 (Continued). Estimated percentage of additional improvement in life-cycle survival needed to achieve indicators of NMFS' jeopardy standard after breaching four Snake River dams. Low and High estimates are based on a range of assumptions, as described in the text. Three assumptions regarding the effect of breaching on delayed mortality of nontransported fish are shown to demonstrate the influence of this assumption on results. A value of, for example, 8 indicates that the egg-to-adult survival rate expected from the RPA, or any constituent life-stage survival rate, must be multiplied by a factor of 1.08 to meet the indicator criteria.

Spawning Aggregation	Needed Survival Change After Implementing Hydrosystem Component of RPA (From Table 9.7-17)		Needed Survival Change if no Change in Non-Transport Delayed Mortality After Breaching (Whether Current Level is High or Low)		Needed Survival Change if Non-Transport Delayed Mortality is Currently High and is Reduced by Half After Breaching		Needed Survival Change if Non-Transport Delayed Mortality is Currently High and is Completely Eliminated After Breaching	
	Low	High	Low	High	Low	High	Low	High
Red R	10	18	6	11	0	0	0	0
Salmon R E Fk	0	2	0	0	0	0	0	0
Salmon R S Fk	0	0	0	0	0	0	0	0
Secesh R	0	0	0	0	0	0	0	0
Selway R	8	15	3	9	0	0	0	0
Sheep Cr	97	110	89	97	0	0	0	0
Upper Big Ck	0	0	0	0	0	0	0	0
Upper Salmon R	13	21	9	14	0	0	0	0
Upper Valley Ck	0	0	0	0	0	0	0	0
Wallowa Ck	42	51	36	42	0	0	0	0
Wenaha R	14	66	9	56	0	0	0	0
Whitecap Ck	14	22	9	14	0	0	0	0
Yankee Fork	26	35	21	27	0	0	0	0
Yankee West Fk	0	0	0	0	0	0	0	0
Snake River Fall Chinook								
Aggregate	0	44	0	32	0	18	0	7
Snake River Steelhead								
ESU Aggregate	58	260	38	214	0	35	0	0
A-Run Aggregate	44	214	25	174	0	18	0	0
A-Run Pseudopopulation	44	214	25	174	0	18	0	0
B-Run Aggregate	92	333	68	278	0	63	0	4
B-Run Pseudopopulation	92	333	68	278	0	63	0	4

over the RPA, and additional improvements through off-site mitigation would still be required. As described in previous sections, NMFS considers empirical information bearing on the question of delayed mortality of nontransported fish to be lacking and information related to differential delayed mortality of transported fish to be very limited. The RPA includes a substantial research effort to help resolve the issue and built-in check points to evaluate new research results with respect to possible future modification of the RPA.

9.7.4 RPA Conclusions

The analysis in the preceding sections of this biological opinion forms the basis for NMFS' conclusions as to whether this RPA for operation of the FCRPS and BOR projects satisfies the standards of the ESA, Section 7(a)(2). To do so, the Action Agencies must ensure that the RPA does not jeopardize the continued existence of any listed species or destroy or adversely modify their designated critical habitat. Section 4 of this opinion defines the biological requirements and the current status of each of the 12 listed salmonid species; Section 5 evaluates the relevance of the environmental baseline to each species' current status; Section 9 details the likely effects of the RPA, both on individuals of the species in the action area and on the listed population as a whole across its range and life-cycle; and Section 7 considers cumulative effects of reasonably certain non-Federal actions within the action area. Based on this background information and analysis, NMFS draws its conclusions about the effects of the operation of the FCRPS and BOR projects, as described in this RPA, on the survival and recovery of 12 listed salmonid ESUs.

As discussed in Section 1.3 of this biological opinion, NMFS must now determine whether the species can be expected to survive with an adequate potential for recovery under the effects of the RPA, the environmental baseline and any cumulative effects, and considering measures for survival and recovery specific to other life stages. A relatively large amount of information, with a substantial amount of quantitative data (i.e., based on empirical observations) is available for ESUs such as SR spring/summer chinook salmon. For other ESUs, such as SR sockeye salmon, primarily qualitative information is available, based on the best professional judgment of knowledgeable scientists. Despite an increasing trend toward a more quantitative understanding of the status of each stock and ESU, critical uncertainties limit NMFS' ability to project future conditions and effects. As a result, there are currently no hard and fast numerical indices available for any of these stocks on which NMFS can base its determination about jeopardy or adverse modification of critical habitat, the Section 7(a)(2) standards. Ultimately, for all 12 ESUs, NMFS must make qualitative judgements based upon the best available quantitative and qualitative information for each species.

9.7.4.1 General RPA Conclusions For All ESUs

In Section 8 of this biological opinion, NMFS concludes that four ESUs will not be jeopardized by the proposed action (UWR and LCR chinook salmon and UWR and LCR steelhead). The RPA will have no adverse effects beyond those described in the proposed action, so NMFS concludes that these ESUs will not be jeopardized by the RPA. In Section 8, however, NMFS also concludes that eight ESUs will be jeopardized by the proposed action. Juvenile and adult mortality in the action area will be substantial, and critical habitat elements, such as water quality and (in the case of CR chum salmon) spawning habitat, will be adversely modified. NMFS concluded that the proposed action was not specific enough regarding measures to improve survival and avoid adverse modification of critical habitat in the action area and that performance standards for guiding improvements were not specific enough and were not tied to biological requirements throughout the life cycle.

Section 8 also indicated that the effects of the proposed action, when combined with anticipated survival improvements in other life stages, were not sufficient to ensure survival and recovery of these eight ESUs. Some additional survival improvements, beyond those considered in analyses of effects, were considered likely to occur as a result of Federal conservation measures related to habitat improvements and hatchery reforms described generally in the Basinwide Recovery Strategy. NMFS concluded, however, that the degree to which these measures will sufficiently augment survival improvements from implementing the proposed action and will ensure a high likelihood of survival and moderate-to-high likelihood of recovery of each ESU is uncertain. In order to conclude that the strategy of progress on non-Federal actions described in the Basinwide Recovery Strategy would provide survival improvements needed to avoid jeopardy, NMFS required a more reliable expectation of progress.

The RPA remedies these two primary shortcomings of the proposed action:

- Measures to improve survival in the action area, specified in detail in Section 9.6.1, are expected to result in higher survival in the action area than would be expected under the proposed action (Section 9.7.1). These measures are guided by explicit action-area performance standards and are integrated with life-cycle performance standards (Section 9.2). Measures also provide specific remedies for adverse modification of critical habitat, such as a gas-abatement program to reduce adverse modification of water quality.

- Section 9.2 of the RPA specifies that the Action Agencies will ensure implementation of enough offsite mitigation to achieve NMFS' estimate of the needed additional survival improvement. Specifics for implementing elements of the Basinwide Recovery Strategy as the Action Agencies' offsite mitigation program are included in Sections 9.6.2 through 9.6.4. In addition, the certainty that the RPA will achieve the survival improvements is increased by the RPA's rigorous evaluation process, by which RPA actions and ESU performance are assessed throughout the RPA's implementation (see Sections 9.4 and 9.5). The RPA thereby greatly increases NMFS' ability to rely on implementation of the non-Federal conservation measures described in the Basinwide Recovery Strategy.

The increased reliability of implementing the Basinwide Recovery Strategy measures, together with other ongoing Federal measures for survival and recovery specific to other life stages and the improved survival that will result from the hydropower measures of this RPA, ensure that each of the eight ESUs will have a high likelihood of survival and a moderate-to-high likelihood of recovery. NMFS' conclusions for all 12 listed ESUs are specified in the following sections.

9.7.4.2 Specific RPA Conclusions

9.7.4.2.1 Snake River Spring/Summer Chinook Salmon

After reviewing the current status of SR spring/summer chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, it is NMFS' biological opinion that the RPA is not likely to jeopardize the continued existence of SR spring/summer chinook salmon or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of SR spring/summer chinook salmon when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.2 Snake River Fall Chinook Salmon

After reviewing the current status of SR fall chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, NMFS concludes that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of SR fall chinook salmon when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.3 Upper Columbia River Spring Chinook Salmon

After reviewing the current status of UCR spring chinook salmon and its factors for decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, it is NMFS' biological opinion that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of UCR spring chinook salmon when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.4 Upper Willamette River Chinook Salmon

Salmonids in the UWR chinook salmon ESU spawn and rear in tributaries that enter the Columbia River downstream from all FCRPS dams. The only effects of operation of the FCRPS on this ESU are potential habitat degradation in the estuary and plume. The magnitude of these effects is uncertain compared to other factors influencing the status of this species. Tables 6.3-13 and 9.7-18 indicate that factors other than the FCRPS limit this ESU's potential for survival and recovery. Therefore, after reviewing the current status of UWR chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the RPA, and cumulative effects, NMFS concludes that the RPA, like the proposed action (see Section 8), is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

9.7.4.2.5 Lower Columbia River Chinook Salmon

As noted in Section 6.2, this ESU is distributed primarily in spawning and rearing areas below Bonneville Dam. The key effects on this species within the action area, summarized in Sections 6.2.9 and 9.7.1, include passage mortality of juveniles and adults from a limited number of spawning aggregations through one dam and reservoir (Bonneville Dam). For the portion of the ESU that was observed to spawn once in the Ives Island area, access to, and the quantity and quality of, that spawning habitat will be affected by FCRPS flow regulation. Tables 6.3-13 and 9.7-18 indicate, however, that factors other than the FCRPS limit this ESU's potential for survival and recovery. Therefore, after reviewing the current status of LCR chinook salmon and the factors for its decline, the environmental baseline in the action area, the effects of the RPA, and cumulative effects, NMFS concludes that the RPA, like the proposed action, is not likely to jeopardize the continued existence of LCR chinook salmon or to destroy or adversely modify its designated critical habitat.

9.7.4.2.6 Snake River Steelhead

After reviewing the current status of SR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, it is NMFS' biological opinion that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of SR steelhead when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.7 Upper Columbia River Steelhead

After reviewing the current status of UCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, it is NMFS' biological opinion that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of UCR steelhead when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.8 Middle Columbia River Steelhead

After reviewing the current status of MCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, it is NMFS' biological opinion that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of MCR steelhead when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.9 Upper Willamette River Steelhead

Salmonids in the UWR steelhead ESU spawn and rear in tributaries that enter the Columbia River downstream from all FCRPS dams. The only effects of operation of the FCRPS on this ESU are potential habitat degradation in the estuary and plume. The magnitude of these effects is uncertain compared to other factors influencing the status of this species. Tables 6.3-13 and 9.7-18 indicate that factors other than the FCRPS limit this ESU's potential for survival and recovery. Therefore, after reviewing the current status of UWR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the RPA, and cumulative effects, NMFS concludes that the RPA, like the proposed action, is not likely to jeopardize the continued existence of LCR chinook salmon or to destroy or adversely modify its designated critical habitat.

9.7.4.2.10 Lower Columbia River Steelhead

As discussed in Section 6.2, this ESU is distributed primarily in spawning and rearing areas below Bonneville Dam. The key effects on this species within the action area, summarized in Sections 6.2.9 and 9.7.1, include passage mortality of juveniles and adults from a limited number of spawning aggregations through one dam and reservoir (Bonneville Dam). Tables 6.3-13 and 9.7-18 indicate that factors other than the FCRPS limit this ESU's potential for survival and recovery. Therefore, after reviewing the current status of LCR steelhead and the factors for its decline, the environmental baseline in the action area, the effects of the RPA, and cumulative effects, NMFS concludes that the RPA, like the proposed action, is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat.

9.7.4.2.11 Columbia River Chum Salmon

After reviewing the current status of CR chum salmon and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, it is NMFS' biological opinion that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, for the component of this ESU that migrates above Bonneville Dam, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements (particularly those affecting critical spawning habitat) of CR chum salmon when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

9.7.4.2.12 Snake River Sockeye Salmon

After reviewing the current status of SR sockeye salmon and the factors for its decline, the environmental baseline in the action area, the effects of the RPA (particularly as described in Sections 9.7.1 and 9.7.2), and cumulative effects, NMFS concludes that the RPA is not likely to jeopardize the continued existence of this ESU or to destroy or adversely modify its designated critical habitat. This conclusion is based on elements of the RPA that remedy shortcomings of the proposed action, as described above. Specifically, the RPA includes measures to improve survival within the action area beyond those anticipated from the original proposed action and to meet action-area performance standards that have been integrated with performance standards for the full life cycle. Additionally, the RPA will result in implementation of enough offsite mitigation that will be targeted to meet the biological requirements of SR sockeye salmon when combined with other elements of the RPA and the conservation measures anticipated in other life stages described in the Basinwide Recovery Strategy.

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